4.2.4 Alternative 4—Removal and Disposal of Abovegrade Structure and Water; Interim Safe Storage of Remaining Facility

Alternative 4 would place the PBF reactor building in interim safe storage. This alternative includes the necessary modifications to the PER-620 facility to ensure that PER-620 is safely stored until the removal of components and materials is initiated at the end of the storage period, as deemed necessary at that time. Alternative 4 would include the removal and disposal of the abovegrade PBF reactor building at the ICDF, RWMC, or CFA industrial landfill, depending on the waste type. Water in the canal, around the reactor, and in various tanks and piping would be removed and disposed of at the ICDF or TRA evaporation ponds or other disposal facility, depending on availability and waste acceptance criteria.

Alternative 4 would include the demolition of the entire abovegrade structure of PER-620 and erection of a new roof system over the PER-620 basement foundation walls to enclose the facility within a weather-protected containment. All existing penetrations of the PER-620 foundation walls would be closed to prevent animal intrusion and water in-leakage into the final safe storage structure. A single access door would be provided to allow periodic inspection of the facility.

This alternative would require continued long-term surveillance and maintenance of the facility to allow the higher radiation levels in the activated and contaminated components and materials to decay to more manageable levels. Once the decay has occurred, the DOE-ID, EPA, and DEQ would determine the final disposition strategy. In contrast to Alternatives 1, 2, and 3, Alternative 4 is not a final action. A HWMA/RCRA storage permit and monitoring might be required under this alternative.

4.2.5 Alternative 5—No Action (Continued Surveillance and Maintenance)

The No Action alternative provides a baseline against which impacts of the other alternatives can be compared. Under the No Action alternative, no removal action would be taken at PER-620, but the current surveillance and maintenance activities and ongoing deactivation activities would continue. The PBF reactor building would remain as it currently exists until deactivation, decontamination, and decommissioning of PER-620 are implemented at a later date.

The No Action alternative requires the continuation of ongoing surveillance and maintenance activities required at an operating facility. At PBF, these include operational surveillances of alarms, chemical storage, safety equipment, and logkeeping; radiological surveillances of radiological instruments, storage areas, and dosimetry; preventive maintenance of utilities, equipment, and instrumentation; calibrations of systems and instrumentation; electricity; and administrative personnel and equipment. Annual costs for these activities are currently estimated to be $1.6 million per year.

This comparatively inexpensive alternative is easily implemented, incurring only costs associated with surveillance and maintenance. However, the No Action alternative offers no reduction in toxicity, mobility, or volume of contaminants. This alternative would not meet the removal action objective of removing the reactor/canal water to reduce the threat to the Snake River Plain Aquifer. For these reasons, the No Action alternative was screened from further analysis in this EE/CA.

5. EVALUATION OF ALTERNATIVES

In accordance with the *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA 1993), each alternative was evaluated with respect to effectiveness, implementability, and cost.

Effectiveness includes protectiveness and the ability to meet the removal action objectives. Effectiveness was evaluated based on (1) protectiveness of the alternative for public health and the community, (2) protectiveness of workers during implementation, (3) protectiveness of the environment, and, (4) compliance with ARARs and other requirements. Ability to achieve removal objectives was evaluated based on (1) level of treatment/containment expected, (2) no residual effect concerns, and (3) maintaining control until a long-term solution is implemented.

Implementability is evaluated based on technical feasibility; availability of equipment, personnel, services, and disposal facilities; and administrative feasibility.

Costs were estimated for each alternative, including capital costs, operations and maintenance (O&M) costs, and present net worth costs. A future time period of 100 years was used to determine future costs and present net worth costs for alternatives involving future actions.

5.1 Practicality Criteria

Alternatives 2 and 3 introduce the issue of practicality, in the context of effectiveness (protectiveness of workers during implementation), as well as implementability (technical feasibility and availability of personnel). As a result, the following practicality criteria are provided, against which these alternatives were evaluated.

Consideration of the interrelationships among the effectiveness, implementability, practicality, and cost criteria is included in the evaluation. For example, the potential benefits of reduction in environmental risk are evaluated with respect to offsetting worker risks and costs, even if the alternative is considered to be practical.

5.1.1 Worker Exposure Practicality Criteria

Practicality for a given alternative is based on (1) the current ICP administrative control levels for worker radiation exposure (700 mrem per year), (2) the goal of avoiding any significant increase in D&D craft labor solely for the purpose of distributing estimated radiation exposures among more workers, and (3) the mandate that work be performed in accordance with the ICP radiation protection standards, the as-low-as reasonably achievable (ALARA) radiation exposure standard, and Integrated Safety Management System (ISMS) practices and guidelines.

Practicality for a given alternative is based on the premise that there must be an overall benefit resulting from any occupational exposure of workers to ionizing radiation, which is the principle underlying the ALARA process. Optimization techniques, including a cost-benefit analysis, are utilized to ensure that worker radiation exposure is ALARA in accordance with 10 CFR 835, "Occupational Radiation Protection," and ISMS practices and guidelines. Evaluation of alternatives in the area of radiation protection includes consideration of the DOE Order 5400.5 ARAR contained in Table 14. That is, basic industry principles of ALARA are considered an ARAR. In addition, worker radiation exposure needs to be addressed on a site-wide collective basis, since overall exposure to the worker population must be addressed relative to administrative control levels.

To accomplish the DOE-ID objective of maintaining individual received radiation doses well below regulatory limits (as defined in 10 CFR 835) and to administratively control and help reduce individual and collective radiation doses, rigorous numerical administrative control levels are established that are below the regulatory limits. These control levels are multitiered with increasing levels of authority required to approve higher administrative control levels. No individual is allowed to exceed the administrative control level without the prior written approval of the facility/project Radiological Control organization, the cognizant facility management, and the INEEL Radiological Control director.

The "Occupational Radiation Protection" regulation (10 CFR 835) requires the INEEL to develop and implement plans and measures to maintain occupational radiation exposures at ALARA levels (10 CFR 835.101[c] and 10 CFR 835.1001). As applied to occupational radiation exposure, the INEEL ALARA process does not require that exposures to radiological hazards be minimized without further consideration, but that such exposures be optimized by taking into account (1) the benefits arising out of the activity, (2) the detriments arising from the resultant radiation exposures, and (3) the controls to be implemented.

An effective ALARA process includes consideration, planning, and implementation of both physical design features (including engineering controls) and administrative controls in order to balance the risks of occupational radiation exposure against the benefits arising out of the authorized activity.

The primary methods used to maintain exposures at ALARA levels is facility and equipment physical design features (see 10 CFR 835.1001[a]). Performance of certain activities such as facility decommissioning could render permanently installed physical design features inadequate. In such instances, engineering controls (e.g., temporary shielding, containment devices, and filtered ventilation systems) are used, as appropriate, to control individual exposures to radiation.

When physical design features, including engineering controls, are impractical or inadequate, the basis should be documented and the work shall be augmented by administrative controls (see 10 CFR 835.1001[a] and [b]).

To evaluate the effectiveness of a control, a cost-benefit analysis uses an established dollar per dose figure to determine if the cost of a control offsets the resultant dose reduction. Values used in the nuclear industry range anywhere from $6,500/person-rem to upwards of $25,000/person-rem with an average value of $10,000/person-rem. These values are used in performing cost/benefit evaluations for work involving worker exposure.

Because of the varied tasks and alternatives for this project, estimating the cost savings from implementing specific engineering and administrative controls to reduce exposure to the workers for the listed alternatives and all associated tasks is not practical. It is anticipated that good ALARA practices are used during the actual work that will reduce worker exposures.

A simple practicality factor is used to evaluate ALARA effectiveness. The number of workers is determined that would be required to complete all tasks required in a specific alternative course of action, while maintaining each worker's occupational radiation exposure at less than the INEEL administrative control level of 700 mrem/year/person. This assumes that the workers are dedicated to this project and will not receive any other radiation exposure during a calendar year. To determine this practicality factor, the total dose estimate for the alternative is divided by the administrative control level value to determine the number of workers needed to complete the tasks under that alternative. This is then compared across the alternative actions.

The alternatives presented are evaluated relative to the worker exposure factors explained above.

5.1.2 Worker Risk Practicality Criteria

As the contractor challenged by the DOE-ID to safely remove excess facilities and reduce the risks to the environment, the ICP must accomplish these difficult tasks safely. The following discussion outlines the risks to employees that are unique to bringing the PBF reactor to an agreed-upon end state and the associated practicality and risk mitigation criteria.

5.1.2.1 Lead Brick Handling. The manual or automated handling of lead bricks could cause airborne concentrations of lead to exceed the Occupational Safety and Health Administration permissible exposure limit of 50 μg/m of air for an 8-hour day. Additional protection measures applicable to this effort are routine air sampling, biological monitoring of the lead worker cadre on a quarterly basis, and four changes of PPE per worker per day. Historical worker exposures for handling large quantities of lead bricks would indicate the selection of a powered air-purifying respirator as the respirator of choice, especially where oxidation of bricks and sheeting is a factor in exposure, which is the case at PBF. Without air-purifying respirators, manual handling could result in overexposure to lead. The removal strategy also requires showering of workers and separate laundering of PPE and separate change areas and eating facilities. Additional considerations include the safety hazards of finger, hand, and other injuries, which can occur during handling of lead bricks; entry into confined spaces; and physical stress from carrying heavy, and in some cases ungainly, lead bricks to a collection point because of inaccessibility of the current location where the bricks have been used.

Surface oxidation is the predominant mechanism under which the corrosion of lead brick and sheet occurs in an oxygenated atmosphere. Oxidized lead can become airborne and constitutes an inhalation hazard unless appropriate respiratory protection is used. The discussion of surface oxidation in Section 5.1.2.1 pertains to oxidation that has occurred while the lead has been in service at PBF. Section 2.5.3 provides a discussion of the corrosion rate of lead in water that may be expected following facility grouting.

5.1.2.2 Ergonomics. The average weight of the ordinary lead brick is approximately 28 lb. Current estimates are that there are more than 14,000 lead bricks in the shielding lead population at PBF. The amount of manual labor required to move, survey, package, and ship this material would expose the workforce to an increase in severe musculoskeletal injuries. Back, shoulder, and extremities are the susceptible body regions for this type of injury. The average age of INEEL workers further predisposes the population to these injuries despite best efforts to mitigate the risk with automation and robotics. Based on projected exposures at the PBF site, and past actuarial data from the INEEL and other DOE laboratories, this category of injury would be the most frequent risk of serious injury with long-term effects to the workforce.

5.1.2.3 Grout Handling. While a tried and true method, grouting a facility of this size and complexity poses its own set of hazards to be considered during the application and use. The grout mixture is corrosive to eyes and skin during prolonged contact. Complete filling of basement spaces requires careful planning because of the risk of engulfment in confined spaces either existing as part of the configuration of the building or those constructed as form work is erected. Risks to personnel include blindness and contact dermatitis. The hoses used for conveyance of the grout into the building also expose the workforce to ergonomic hazards similar in nature to those outlined in Section 5.1.2.2. In addition, care must be given to pressure discharges and associated potential failures in the performance of this type of work.

5.1.2.4 Heat-Related Disorders. Work performed in removing lead, activated components, and other radiological and hazardous material abatement requires the use of multiple forms of PPE. The wearing of PPE to shield workers from the ambient environment interferes with normal body-temperature control mechanisms (such as sweating) and thus increases the risk of heat-related illnesses and injuries, especially when used in multiple layers while engaged in heavy work, as this effort would require. The hazard of heat-related disorders to employees is the second most frequently occurring serious risk to employees engaged in this work. If not properly managed and mitigated, some of these disorders can be fatal. Again, coupled with associated time constraints as well as having to perform work in areas possessing elevated radiation fields, the intensity of a heat-stress-related incident is increased dramatically.

5.1.2.5 Employee Empowerment. The removal of some of the lead shielding block might not be possible because of the risk of exposure to high radiation fields as well as imminent danger to employees based on the hazards of removal presented and evaluated at the time. It is the responsibility of every INEEL employee to stop work if the worker feels exposed to an uncontrolled or unacceptable hazard.

The alternatives presented are evaluated relative to the worker risk factors explained above.

5.1.3 Technological and Cost Practicality Criteria

Technological practicality criteria go hand-in-hand with worker exposure and worker risk criteria; that is, to the extent that the work cannot be performed manually, remote or robotic applications might be appropriate, but are also subject to practicality criteria expressed in terms of technology availability, cost, and delivery.

Practicality criteria are based on technology and equipment that are commercially available or readily available at a reasonable cost and delivery schedule. To provide the maximum amount of flexibility (hands-on vs. noncontact) during the lead removal activity, remote equipment would be desirable. The INEEL currently has available a BROKK 250 remote demolition unit that could be used to remove some of the piping and structures and to access various lead shielding areas. However, because of its size, this piece of equipment would not be capable of removing and sizing all of the piping and structures necessary to access the multiple areas of lead shielding. Various end effectors and possibly an additional BROKK unit might be required to achieve the acceptable personnel exposure goals. Furthermore, this equipment would not be well suited to bulk removal of shielding lead bricks. Therefore, existing available equipment would improve but not substantially reduce worker risks.

The additional technology required to substantially reduce worker risks also might include additional remote equipment such as elevators or lifts to remove the lead out through the ceiling hatches or a remotely operated front end loader or fork lift to remove the lead through an exterior door that would be cut into the north wall of the first basement. Additional remote equipment for size reduction, packaging, or demolition also might be required.

Therefore, in conclusion, the alternatives presented are evaluated to determine if remote or robotic equipment should be commercially available or readily available custom application equipment that is able to be procured at a reasonable cost and on a schedule consistent with ICP and DOE-ID schedule objectives.

5.2 Alternative 1

Removal and disposal of water in tanks and piping would be performed as described in Section 4.1.1. Grouting the remaining substructure and contents in place would take place as described in Section 4.1.2. Installation of the performance-based cover would take place as described in Section 4.1.2. Removal and disposal of the abovegrade structure would take place as described in Section 4.1.3. Postclosure care and monitoring would take place as described in Section 4.1.4.

5.2.1 Effectiveness of Alternative 1

The two subcriteria for evaluating effectiveness are protectiveness and the ability to meet the removal action objectives.

5.2.1.1 Alternative 1—Protectiveness. This alternative would be protective of public health, the community, and the environment when the removal action has been completed, because the contaminants present in the PBF reactor building either would be removed and disposed of at an appropriate disposal facility or would be grouted in place and covered with a performance-based cover. This would place the remaining hazardous substances (both radiological and chemical) in a controlled, stabilized monolith with a protective cover designed to prevent access to the contaminants from the surface and to significantly reduce contaminant migration to groundwater.

The risk assessment in Section 2.5 demonstrates that leaving contaminants in place in the building substructure would not pose unacceptable risk through the groundwater exposure pathway nor would it cause the Idaho Ground Water Quality standards (maximum contaminant levels) to be exceeded. The installation of grout and a concrete/soil cover would prevent surface exposures (direct and dermal) in excess of the removal action goals.

Following the removal action, long-term monitoring of groundwater conditions and cover integrity would provide ongoing assurance of protection of public health, community, and the environment.

During the removal action, the action would be protective of health, the community, and the environment through the use of engineering and work process controls. The potential for worker exposure is low and can be controlled through engineering and work process controls during removal of contaminated water and the abovegrade structure and during grouting. The risks associated with grout handling described in Section 5.1.2.3 are considered to be manageable.

Worker exposure during implementation of Alternative 1 was estimated by examining the specific individual activities involved in accomplishing the overall tasks and objectives, determining estimated times in which work would be performed in locations with radiation exposure fields, estimating crew sizes, determining overall estimated hours for work to be performed, and using estimated radiation exposure rates based on current facility information and surveys. Buildup and estimated overall personnel exposure results for Alternative 1 are provided in Table 8. This level of worker exposure is considered to be acceptable at the estimate level; however, consistent with ALARA principles, every effort would be made to minimize worker radiation exposure.

Alternative 1 would comply with all ARARs. The water would be treated through evaporation at the ICDF evaporation ponds or the TRA evaporation ponds, depending on availability and waste acceptance criteria. A small amount of water may be disposed of at a suitable treatment and disposal facility, if necessary. Based on existing analytical results, the water generated from the PBF reactor building would not be a hazardous waste. The primary contaminants of concern are radionuclides. Hazardous waste determinations would be made, as required, to demonstrate that the water would meet the ICDF or TRA waste acceptance criteria.

Table 8. Alternative 1 estimated personnel radiation exposures.

Decommissioning Activity	Hours	Personnel	Total Hours	Dose Rate (mrem/hr)	General Exposure (mrem)[a]	Incremental Exposure (mrem)[b]	Total Exposure (mrem)
Remove abovegrade PBF reactor building.[c]							
Internal D&D	320	5	1,600	0	—	—	—
Annex D&D	160	5	800	0	—	—	—
External D&D	600	5	3,000	0	—	—	—
Drain and dispose of reactor, canal, and piping water.							
Equipment setup, remove, and transport reactor vessel water	200	3	600	0	—	—	—
Equipment setup, mockup and plan, remove, and transport primary coolant piping water	160	3	480	0	—	—	—
Fire protection	80	3	240	0	—	—	—
Core drilling							
Drill 116 holes for grout injection/vent (2 hours/hole).	232	2	464	0.25	116	—	116
Ventilation							
Install temporary HVAC system [d]	463	3	1,388	0	—	—	—
Knockout drum room[e]	8	3	24	25	—	600	600
Piping fill/vent lines							
Install fill and vent lines on primary piping.	80	3	240	0.25	60	—	60
Isolate piping and electrical services							
Isolate Motor Control Center loads and verify zero energy.	65	3	195	0	—	—	—
Cut and cap piping inside basement wall	144	5	720	0.25	180	—	180
Cut and cap piping and conduit outside basement wall.	32	5	160	0	—	—	—
Work planning and field verification	20	4	80	0	—	—	—
Construct forms/grout exterior wall penetrations.							
Pipe grouting	36	5	180	0	0	—	—
Electrical grouting	12	5	60	0	0	—	—
Pipe supports							
Install 25 pipe supports, cut 62 grout vents, and fill notches.	388	3	1,164	0.25	291	—	291
Totals	—	—	**11,395**	—	**647**	**600**	**1,247**

a. The dose rate used for general activities in the PBF was based on the average of general radiation fields in the facility of 0 mrem/hr. This general area dose rate is used except for those identified at higher rates.

b. An incremental dose rate is added for the additional radiation exposure from unshielded components as the current shielding is removed. This can be mitigated by temporary shielding.

c. Labor hours are generated from the project cost estimate assuming a five- or eight-man crew in the work area at a given time. Demobilization and shipping/handling exposures are considered negligible and are excluded unless indicated otherwise.

d. Assume ventilation/flapper installation in Cubicles 10 and 13 is not required.

e. Knockout drum room's radiation fields are highly variable. An average field of 25 mrem/hr is assumed for incremental dose

D&D = decontamination and decommissioning
HVAC = heating, ventilation, and air conditioning
PBF = Power Burst Facility

Waste disposal facilities are available at the INEEL to accommodate the waste generated during removal of the PBF reactor abovegrade structure and the hot waste tank structure. The waste is anticipated to meet the waste acceptance criteria for the ICDF landfill (DOE-ID 2003b). Other on-Site facilities that may be used for management of the waste include the Landfill Complex at the CFA and the RWMC. Waste not complying with the ICDF waste acceptance criteria may be staged/stored for disposal at an on-Site or off-Site facility, subject to meeting its waste acceptance criteria. Building materials or contents would be recycled to the extent possible.

As a CERCLA project, this removal action is not required by law to obtain permits for on-Site activities performed within the scope of the removal action (42 USC § 9621[e][1]). Nevertheless, the DOE-ID may consider obtaining a HWMA/RCRA landfill postclosure permit from DEQ as a means of satisfying the substantive landfill closure requirements that apply to this activity.

5.2.1.2 Alternative 1—Ability to Achieve Removal Action Objectives. Alternative 1 would meet the removal action objectives by removing the abovegrade PBF reactor structure (PER-620) and water contained in the PBF reactor building. The contaminants would be stabilized, as required, and disposed of at the ICDF or other acceptable facility. The risk assessment (Section 2.5) demonstrates that the residual contaminant source would not cause the Snake River Plain Aquifer to exceed the Idaho groundwater quality standards in the future. The removal action would be expected to serve as the final action for the PBF reactor building. Institutional controls would be required after the removal action is completed, because contaminants would remain grouted in place, such that unrestricted access could not be allowed. These institutional controls would be incorporated into the institutional controls managed under the Record of Decision (DOE-ID 2000) or the OU 10-08 Record of Decision, as determined by the DOE-ID, EPA, and DEQ.

5.2.2 Implementability of Alternative 1

5.2.2.1 Technical Feasibility of Alternative 1. Alternative 1 would be technically feasible. The methods used to remove and stabilize the abovegrade structure are not technically complex, but do require special considerations to ensure worker protection from radiation exposure. The removal, stabilization, and disposal of the debris would require careful operational controls to minimize worker exposure and to prevent the spread of contamination. The contaminated water would be sent to the ICDF evaporation ponds, TRA evaporation ponds, or, if necessary, to another suitable facility for treatment and disposal. The facilities exist at the ICDF, TRA, and off-Site to accomplish this task.

The removal of water from the PBF reactor would include several steps, all of which are technically feasible. The inventory of water in the facility would be further evaluated to ensure that all water remaining in the vessels, equipment, and piping is identified. Water that has not been adequately characterized for radioactive and nonradioactive contaminants would be characterized. Water would be disposed of in accordance with the ARARs, depending on the waste characterization results.

Grout placement is technically feasible. A plan would be developed to sequence the placement of grout, which would include determining anchoring needs for tanks, equipment, and other debris in order to preclude equipment floating or breakage due to buoyancy or changing centers of gravity as grout is introduced. This plan also would include developing adequate venting, using the existing ventilation system to the extent possible; cutting and capping all process and waste lines that exit the structure below grade; and designing a grout delivery system. All of this would be accomplished using existing construction/demolition techniques for grout emplacement.

The placement of a performance-based cover over the grouted substructure is technically feasible. Similar covers have been installed at other locations at the INEEL. Installation of additional monitoring wells and routine sampling and analysis of the monitoring network to implement postclosure care requirements are technically feasible. Alternative 1 would be expected to take about 1 year to implement.

5.2.2.2 Availability of Alternative 1. Alternative 1 has few constraints with respect to availability. The equipment necessary to implement the removal action is commercially available or is currently available at the INEEL. Personnel and services also would be available, although the project might compete with other INEEL projects for resources. Laboratory testing capabilities exist on-Site and would be available for this alternative.

The ICDF and RWMC would be the assumed locations for disposal of the water, waste, and much of the debris. It is assumed that the PBF water would meet the ICDF evaporation pond's waste acceptance criteria. If the ICDF is unavailable or unable to accept PBF reactor facility water, the TRA evaporation ponds may be used to treat and dispose of the water. The TRA evaporation ponds are expected to be available, but their use would require coordination with TRA operations. To accelerate the removal of water from certain small tanks, smaller quantities of water may be shipped to another suitable facility for treatment and disposal.

The materials and equipment for placement of a performance-based cover over the grouted substructure are readily available to the INEEL. Similar covers have been installed at other locations at the INEEL. Other well installations and sampling are conducted routinely at the INEEL, and equipment and materials for installation of additional monitoring wells are available.

5.2.2.3 Administrative Feasibility of Alternative 1. Administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and near the PBF with disposal at the ICDF Complex, TRA evaporation ponds, RWMC, or other suitable disposal facility. As a CERCLA project, this removal action would not require permits for on-Site activities; however, the DOE-ID is considering obtaining a HWMA/RCRA landfill postclosure permit as a method of satisfying the applicable substantive standards of the landfill postclosure regulations. No easement issues would exist. Right-of-way issues would not exist for trucking the water from PBF to the TRA evaporation ponds or water and other waste to ICDF facilities, because the trucks would not cross or travel along public highways. However, if waste was sent to the RWMC for disposal, it would cross public highways, and U.S. Department of Transportation regulations would apply. There would be no impacts on adjoining properties from implementation of Alternative 1.

The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For Alternative 1, institutional controls would be required after completion of the removal action, because contamination would be left grouted in place in the subsurface structure. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.

5.2.3 Cost of Alternative 1

The total escalated cost to implement Alternative 1 is $15.4 million. In net present value, this equates to $8.4 million. The capital costs include costs for the isolations, deactivation, grout placement, demolition of the abovegrade structures, construction of the cover, waste disposal, and installation of two monitoring wells. A 100-year postclosure monitoring period is assumed. The monitoring costs included in the total cost above are estimated at $9.0 million (or $1.4 million in net present value).

5.2.4 Evaluation Summary—Alternative 1

Alternative 1 is protective relative to the defined public health and community, environment, worker, and ARAR compliance effectiveness criteria. Alternative 1 is considered to be implementable. In addition, Alternative 1 represents the lowest net present value total cost among the alternatives that provide a final action. Additional comparative analysis detail is provided in Section 6.

5.3 Alternative 2

Removal and disposal of the abovegrade structure and water would be performed as described in Section 4.1.1. Grouting the remaining substructure and contents in place would take place as described in Section 4.1.2. Installation of the performance-based cover would take place as described in Section 4.1.2. Postclosure care and monitoring would take place as described in Section 4.1.3.

As compared to Alternative 3, this alternative calls for removal of only that shielding lead, and radioactive resin that can be practically removed. A summary of the practicality determinations made is provided in Table 9. Discussion of the bases for these conclusions is provided in Section 5.3.

5.3.1 Scope Summary and Discussion—Partial Removal of Shielding Lead

It is anticipated that lead to be removed would be placed in waste boxes for ultimate macroencapsulation and disposal at an appropriate disposal facility. In addition, the 147 lb of cadmium sheeting associated with the Fission Product Detection System would be removed. It is anticipated that every effort would be made to utilize remote or mechanical material-handling approaches in order to reduce worker risk and radiation exposure. Packaged lead would be removed through facility equipment hatches. Consideration also has been given to creating a new external access through a previous building construction opening.

Shielding lead would be removed from the facility in the approximate quantities listed in Table 9. As noted, practicality determinations are based on current information and may change based on concealed or new conditions occurring during the actual removal operations. Concealed conditions may include, for example, unexpected radiological source terms, obstructions, or physical conditions.

5.3.2 Effectiveness of Alternative 2

As shown in Table 10, this alternative results in the removal of a significant amount of contaminants from the PBF reactor building. More specifically, all the shielding lead and radioactive resin beds that can be removed practicably would be removed prior to grouting and postclosure monitoring. The contaminants affixed to component and equipment interior surfaces, walls, and floors would remain in place. These remaining contaminants would be stabilized in place through the addition of grout to the substructure. The two subcriteria for evaluating effectiveness are protectiveness and the ability to meet the removal action objectives.

Table 9. Alternative 2 practicality determination summary.

Material	Estimated Inventory	Practicality Determination: Practical[a]	Practicality Determination: Not Practical
RADIONUCLIDE INVENTORY			
Activated materials			
Inpile tube	56 Ci		56 Ci
Reactor vessel	22 Ci		22 Ci
Contaminated resin beds			
Out-of-service loop cleanup resins in Cubicle 10	< 8 Ci		< 8 Ci
Canal cleanup warm waste room	1 Ci		1 Ci
In-service canal cleanup resins, I	< 1 Ci	< 1 Ci	
Out-of-service canal cleanup resins, II	< 1 Ci	< 1 Ci	
Surface contamination	13 Ci		13 Ci
NONRADIONUCLIDE INVENTORY			
Shielding lead (lb)			
Cubicle 13			
Blowdown tank	113,000	113,000	
Fission Product Detection System cave	66,300	66,300	
Lead panels	10,300	10,300	
Other	2,900	2,900	
Subtotal	192,500	192,500	
Cubicle 10			
Loop cleanup resin columns			
Outer block course	24,650		24,650
Inner block course	24,650		24,650
Loop strainer	54,400		54,400
Other	4,700		4,700
Subtotal	108,400		108,400
Reactor annulus	2,700	2,700	
Sample room	7,600	7,600	
Other areas	11,000	11,000	
Subtotal	21,300	21,300	
Total shielding lead (lb)	322,200	213,800	108,400
Total radioactive materials (Ci)	< 102 Ci	< 2 Ci	< 100 Ci

a. Practicality determinations are based on current information and may change based on concealed or new conditions occurring during the actual removal operations. Concealed conditions may include, for example, unexpected radiological source terms, obstructions, or physical conditions.

Table 10. Alternative 2 estimated personnel radiation exposures.

Decommissioning Activity	Hours	Personnel	Total Hours	Dose Rate (mrem/hr)	General Exposure (mrem)[a]	Incremental Exposure (mrem)[b]	Total Exposure (mrem)
Complete all activities included in Alternative 1.	—	—	11,395	—	647	600	1,247
Shielding lead removal (where practical)							
Cubicle 13							
Mobilization	40	5	200	1	200	—	200
Piping removal packaging and shielding	40	3	120	10	1,200	—	1,200
Blowdown tank shield wall	120	3	360	5	1,800	—	1,800
Fission Product Detection System cave	80	3	240	5	1,200	—	1,200
Shield panels	10	3	30	5	150	—	150
Miscellaneous	5	3	15	5	75	—	75
Incremental lead removal[e]	20	3	60	50		3,000	3,000
Sample room	40	3	120	0.5	60	—	60
Reactor annulus	20	3	60	5	300	—	300
Knockout drum room	2	2	4	25	100	—	100
Warm waste room	4	2	8	0.25	2	—	2
Hatch Cover 4	2	2	4	0.25	1	—	1
Totals	—	—	**12,616**	—	**5,735**	**3,600**	**9,335**

a. The dose rate used for general activities in the PBF was based on the average of general radiation fields in the facility of 0 mrem/hr. This general area dose rate is used except for those identified at higher rates.

b. An incremental dose rate is added for the additional radiation exposure from unshielded components as the current shielding is removed. This can be mitigated by temporary shielding.

c. The dose rate used for activities in the annulus and subpile room is assumed to be about 10 mrem/hr on average, although hot spots are present.

d. The incremental dose rate applied is due to activities around the Reactor Plant Control System piping with no water in the reactor basin. Assuming proximity to the core and shielding, the assumed dose rate is 25 mrem/hr from the reactor vessel and other sources.

e. Assumes 10% of lead is removed at increased dose rate.

PBF = Power Burst Facility

5.3.2.1 *Protectiveness of Alternative 2.* Alternative 2 would be protective of public health, the community, and the environment when the removal action has been completed, because many of the contaminants present in the PBF reactor building would be removed and those contaminants remaining would be immobilized in place. The building debris, practicably removable contaminated resins, and practicably removable lead shielding would be stabilized (as required) and disposed of at the ICDF, RWMC, or other acceptable on-Site disposal facility. This would place most of the contaminant sources in a controlled configuration in the ICDF, which is a landfill specifically designed to prevent access to the contaminants from the surface and to prevent contaminants from reaching the Snake River Plain Aquifer in concentrations that would exceed Idaho groundwater quality standards or risk-based limits.

The scope, details, and impacts of removing the reactor vessel are provided in Section 5.4.2. As described, this activity would involve significant risk, including radiation exposure, and would not be considered practical to perform. Furthermore, there would be no long-term risk reduction benefits that would compensate for these worker risks.

The scope, details, and impacts of removing the IPT are provided in Section 5.4.1. While removal of the IPT would be somewhat more practical to perform than the removal of the reactor vessel, there is no readily available disposal path for the IPT. Thus, removal of the IPT is considered impractical.

Immobilization of the residual radioactive and nonradioactive contaminants in the building substructure through addition of grout would inhibit migration of those contaminants to the Snake River Plain Aquifer and therefore help to meet the removal action objectives. Nevertheless, the risk assessment in Section 2.5 demonstrates that even without grouting, the remaining contaminants would not pose a threat to the aquifer. During the removal action, the action would be protective of health, the community, and the environment through the use of engineering controls.

Following the removal action, long-term monitoring of the groundwater and cover would provide ongoing assurance of protection of public health, the community, and the environment.

During the removal action, the action would be protective of health, the community, and the environment through the use of engineering and work process controls. The potential for worker exposure is high; however, it can be controlled largely through engineering and work process controls during removal of contaminated water and the abovegrade structure and during grouting.

Worker radiation exposure during implementation of Alternative 2 was estimated by examining the specific individual activities involved in accomplishing the overall tasks and objectives, determining estimated times in which work would be performed in locations with radiation exposure fields, estimating crew sizes, determining overall estimated hours for work to be performed, and using estimated radiation exposure rates based on current facility information and surveys. Buildup and estimated overall personnel exposure results for Alternative 2 are provided in Table 10. This level of worker exposure is considered to be marginally acceptable at the estimate level. Consistent with ALARA principles, every effort would be made to minimize worker radiation exposure.

In addition to worker radiation exposure, removal of the shielding lead inventory identified in Table 9 would introduce substantial worker risk. More specifically, this activity would introduce the worker risks identified in Section 5.1.2; namely, the risks associated with lead brick handling (airborne lead concentrations; finger, hand, and other injuries; and confined space work), as well as the ergonomic and heat-related risks also described. For these reasons, this alternative is also considered to be at best marginally acceptable with respect to worker risk.

Table 9 provides a summary of the practicality determination results, including Alternative 2. This subsection provides the supporting discussion for those determinations for Alternative 2. This discussion is provided in the context of the overall effectiveness criteria, since impracticality limits have been identified in the area of worker protectiveness. Evaluation relative to the worker exposure and worker risk practicality criteria results in a conclusion that not all of the shielding lead can be removed. More specifically, the lead shielding bricks around the resin columns cannot be removed. As shown in Table 10, average exposure rates inside these columns are estimated to be approximately 100–200 mrem/hour. Survey results support this conclusion and show rates as high as nearly 600 mrem/hour. Removal of the lead bricks from Cubicle 10 requires the cutting and removal of piping that obstructs access to the bricks. Since the estimated dose to remove that piping is 10,000 mrem, prior to the removal of lead, it was deemed impractical to remove. Extremely high personnel exposure rates are estimated based on work in these fields, and the total exposure rates are based on the amount of time workers would need to spend in these fields. For these reasons, this population of shielding lead was not included in the scope of Alternative 2.

However, impracticality limits also are identified in the context of the overall implementability criteria, since personnel resources would not be available to perform the projects involving large estimated personnel exposures. Conversely, evaluation of alternative methods of removal using remote or robotic approaches has resulted in a determination that technology availability and cost limits also would be reached.

Some remote capabilities and equipment such as a BROKK 250 remote demolition unit is available at the INEEL. This equipment might be useful, but would not eliminate the worker exposures and risks identified. Additional equipment would need to be procured and factored into the overall cost and schedule of the project. Certain equipment is commercially available; however; cost and delivery times on the order of 4–6 months are not consistent with ICP and DOE-ID schedule requirements. Furthermore, this equipment would need to be customized and tailored to meet the specific project needs in order to substantially reduce the identified worker exposures and risks.

In conclusion, removal of all the shielding lead around Cubicle 10 is not considered practical, nor is removal of the reactor vessel and inpile tube.

Alternative 2 would generally comply with ARARs and other requirements. However, the additional worker exposure with no associated risk reduction is inconsistent with the principles of ALARA, as defined in DOE Order 5400.5 and 10 CFR 835. Therefore, conformance to this requirement is an issue. The collective effects of worker radiation exposure for this alternative have not been evaluated, since the full scope of work has not been defined for the time period in which the work would be performed.

The building debris, contaminated reactor, lead shielding, and loose, contaminated particles that would be removed from the PBF reactor building would be stabilized (as required) to meet the disposal facility's waste acceptance criteria.

This alternative would remove about half of the lead shielding from the PBF reactor building. This lead would become a CERCLA waste requiring management to meet ARARs when it is removed from its current locations, as it is expected to exceed the limits described in 40 CFR 261.24, "Toxicity Characteristic," of RCRA. The stabilization of the removed lead through macroencapsulation would result in a waste form that meets the ICDF's waste acceptance criteria and satisfies the substantive ARAR requirements of the HWMA/RCRA land disposal restrictions.

Hazardous waste determinations would be made (as required) to demonstrate that the building debris, contaminated reactor, lead shielding, and loose, contaminated particles would meet the disposal facility's waste acceptance criteria.

As a CERCLA project, this removal action is not required by law to obtain permits for on-Site activities performed within the scope of the removal action (42 USC § 9621[e][1]). Nevertheless, the DOE-ID may consider obtaining a HWMA/RCRA landfill postclosure permit from DEQ as a means of satisfying the substantive landfill closure requirements that apply to this activity.

5.3.2.2 Alternative 2—Ability to Achieve Removal Objectives. Alternative 2 would meet the removal action objectives by removing the abovegrade PBF reactor structure (PER-620), water contained in the PBF reactor building (including inside the reactor vessel), and much of the lead shielding and contaminated resins. This would be followed by in-place grouting of the remaining building substructure and large components and equipment. The removed contaminants and contaminated media would be stabilized (as required) and disposed of at the ICDF, RWMC, or other acceptable disposal facility. The streamlined risk assessment (Section 2.5) demonstrates that the residual contaminant source would not cause the Snake River Plain Aquifer to exceed the Idaho groundwater quality standards or applicable risk-based concentrations in the future.

The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For Alternative 2, institutional controls would be required after completion of the removal action, because residual contamination would be left grouted in place in the subsurface structure. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.

5.3.3 Implementability of Alternative 2

5.3.3.1 Technical Feasibility of Alternative 2. Alternative 2 would be technically feasible, but presents technical challenges that would not exist with Alternatives 1 or 4 because of the removal of most of the shielding lead.

Alternative 2 would include the removal of all water remaining in the PER-620 facility as identified in Alternative 1 with the addition of the water in the reactor vessel. Water in the reactor vessel would be removed using engineering controls to limit the radiation exposure to workers.

The removal of shielding lead is technically feasible, but would require complex engineering and work process controls to minimize worker exposure. Alternative 2 would be expected to take 1 to 2 years to implement.

5.3.3.2 Availability of Alternative 2. Alternative 2 has some constraints with respect to availability. The equipment necessary to implement the removal action is commercially available or is currently available at the INEEL. Personnel and services also would be available, though this project might compete with other INEEL projects for resources. Laboratory testing capabilities exist on-Site and would be available for the removal action.

The ICDF or RWMC would be the assumed location for disposal of the hot waste storage tank (PER-732), the contaminated reactor, lead shielding, and loose, contaminated particles. Selection of the disposal site would depend on the waste characteristics and the waste acceptance criteria of the disposal site. Contaminated debris would be disposed of at the ICDF, RWMC, or the CFA Landfill Complex, depending on the waste characteristics and the waste acceptance criteria of each facility. Lead waste generated in Alternative 2 would be sent to an appropriate facility for macroencapsulation prior to disposal. These facilities would be available during implementation of the removal action. The ICDF evaporation ponds or the TRA evaporation ponds are the assumed disposal location for the contaminated water. At least one of the two facilities is expected to be available during implementation of the removal action.

The materials and equipment for placement of a performance-based cover over the grouted substructure are readily available to the INEEL. Similar covers have been installed at other locations at the INEEL. Other well installations and sampling are conducted routinely at the INEEL, and equipment and materials for installation of additional monitoring wells are available.

5.3.3.3 Administrative Feasibility of Alternative 2. Administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and adjacent to the PBF with disposal at the ICDF and ponds, TRA evaporation ponds, RWMC, or other suitable facility. As a CERCLA project, this removal action would not require permits for on-Site activities; however, the DOE-ID is considering obtaining a HWMA/RCRA landfill postclosure permit as a method of satisfying the applicable substantive standards of the landfill postclosure regulations. No easement issues would exist. Right-of-way issues would not exist for trucking the water from PBF to the TRA evaporation ponds or water and other waste to ICDF facilities, because the trucks would not cross or travel along public highways. However, waste that would be sent to the RWMC for disposal would cross public highways, and U.S. Department of Transportation regulations would apply. There would be no impacts on adjoining properties from implementation of Alternative 2.

The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For Alternative 2, institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.

5.3.4 Cost of Alternative 2

The total escalated cost to implement Alternative 2 is $19.6 million. In net present value, this equates to $12.4 million. The capital costs include costs for the isolations, deactivation, removal of some shielding lead, grout placement, demolition of the abovegrade structures, construction of the cover, waste disposal, and installation of two monitoring wells. A 100-year postclosure monitoring period is assumed. The monitoring costs included in the total costs above are estimated at $9.0 million (or $1.4 million in net present value).

5.3.5 Evaluation Summary—Alternative 2

Alternative 2 is protective relative to the defined public health and community, environment, and ARAR compliance effectiveness criteria. It is marginally protective of the workers, since the associated radiation exposure is relatively high—approximately 20% of the total annual INEEL dose for the entire site in 2003. The additional worker exposure with no associated risk reduction is inconsistent with the principles of ALARA, as defined in DOE Order 5400.5 and 10 CFR 835. Therefore, conformance to this requirement is an issue.

Alternative 2 is considered to be implementable. Alternative 2 represents the second highest net present value total cost among the alternatives that provide a final action, and it would be $4,300,000 more expensive than Alternative 1.

The groundwater pathway risk assessment demonstrated that long-term environmental risk is acceptable even with no retrieval of nonradiological or radiological inventory. There are no net benefits of Alternative 2 in further reducing this risk by removing a portion of this inventory, which might offset the higher worker risk or cost. Additional comparative analysis detail is provided in Section 6.

5.4 Alternative 3

Removal and disposal of water in tanks and piping would be performed as described in Section 4.1.1. Grouting the remaining substructure and contents in place would take place as described in Section 4.1.2. Installation of the performance-based cover would take place as described in Section 4.1.2. Removal and disposal of the abovegrade structure would take place as described in Section 4.1.3. As compared to Alternative 2, this alternative calls for removal of all lead, activated material, and radioactive resin beds. Further discussion of practicality criteria and evaluation results for this alternative is contained in Section 5, "Evaluation of Alternatives."

A small amount of equipment and facility surface contamination would be left in place. As a result, the substructure and contents would be filled with cementitious grout, and a performance-based cover would be installed.

As compared to Alternatives 1 and 2, postclosure care, installation of new monitoring wells, ongoing monitoring, and other related activities are not considered necessary since this alternative eliminates the nonradionuclide lead inventory and essentially eliminates the radionuclide material inventory.

5.4.1 Scope Summary and Discussion—Removal of Inpile Tube

The IPT is currently stored in a support stand mounted in the PBF reactor vessel. Since the IPT contains a relatively high level of activated material, the feasibility of the removal and disposal of the IPT has been evaluated. The steps envisioned include (1) constructing a shielded container for transportation and disposal/storage, (2) rigging the IPT, (3) cutting the IPT nozzles, (4) draining and placing the IPT in the shielded container, (5) transporting it to the disposal/storage location, and (6) placing it in the disposal/storage location.

The IPT would require a shielded container for shipping and disposal purposes to reduce the exterior radiation levels to acceptable levels. Design concepts for such a container have been developed. A 10-in.-diameter pipe section would be enclosed within a 36-in.-diameter standard pipe with standard density concrete placed in the annular space between the outer side of the inner IPT guide pipe and the inside wall of the outer shell providing 12 in. of concrete shielding. A bolted-top lid and welded bottom closure plates would seal the container. The estimated empty dry weight of the shielded container is over 15,000 lb. An alternative design may be used if acceptable to the disposal facility, which is currently expected to be the RWMC.

The IPT would be required to be lifted out of the reactor vessel and supported with the nozzles above water and the activated portion below the water. A support bracket would be fabricated, which can support the IPT from its support plate. The lift fixture is currently attached to the top of the IPT. The crane would be used to lift the IPT and place it in the support fixture.

If the 36-in. shielded container described in #1 above is required by the disposal facility, then the nozzles would be required to be sized to fit within the inner diameter of the container. With the IPT located on the support fixture and the activated portion on the lower section below the water level, the nozzles would be slung from the crane or otherwise kept from falling and would be cut with a band saw or other equipment. This step would not be required if the disposal facility can accept a larger container that does not require sizing.

To meet the disposal requirements of the RWMC, all water must be removed from the interior of the IPT. Tubing would be inserted into the interior of the IPT through one of the nozzles and a pump would be used to pump the water out and into the basin or other storage container. An absorbent may be added to dry any remaining moisture.

The shielded container would be placed in the deep pit with cribbing to ensure that it stays upright. The IPT would then be lifted above the canal gate and placed into the container. Since the IPT is highly activated and has a radiation rate of ~70 rem/hour, employees would be kept as far away as possible and shielding would be used to minimize personnel exposure. The lid is then placed on top of the shipping container with long-reach tools using a guide pin to ensure that the lid is positioned properly. The bolts would then be tightened to secure the lid.

To transport the IPT in its container to the RWMC, a transport and tie-down plan would be required. During transport, the shipment would require a security escort. After arriving at the RWMC, the IPT in the shielded container would be disposed of in the low-level waste pit.

Notwithstanding the conceptual design details explained above, the viability of disposing of the IPT at the RWMC or elsewhere on-Site is not clear.

5.4.2 Scope Summary and Discussion—Removal of Reactor Vessel

The reactor vessel and core internals contain 22 Ci (or approximately 21% of the total remaining radionuclide inventory). The feasibility of removing the vessel and core components was evaluated to determine whether it could be achieved in a cost-effective manner while ensuring worker protection. Removing the reactor consists of the following steps: (1) determining final disposition pathway, (2) arranging and/or modifying a shipping trailer, (3) isolating and disconnecting mechanical systems, (4) physically disconnecting the vessel from the building structure, (5) installing a lifting fixture, (6) accessing the vessel through the roof, (7) lifting and loading the vessel, (8) transporting it to the disposal facility, and (9) disposing of the reactor.

The final disposition of the reactor vessel and internal components would have to be determined. At this time, it is expected that it can be disposed of in the RWMC without a container or without sizing. Because of its size (29 ft tall and 15 ft in diameter), a trailer capable of shipping the vessel must be arranged and/or modified.

A trailer would have to be arranged and potentially modified to transport the vessel and internal components. It is estimated to weigh approximately 140,000 lb and is 15 ft in diameter. A transport and tie-down plan also would be required.

All of the mechanical systems that are connected to the reactor vessel or the internal components must be disconnected and removed. The activated core components are located within the reactor vessel. A preliminary evaluation of removal of the core components without the reactor vessel indicates that it would potentially result in significantly higher personnel radiation exposure as a result of working in closer proximity of the activated components. In addition, disposal of the core components alone is uncertain. The reactor vessel is surrounded by an annular space that, while accessible, is fairly tight with numerous obstructions. Systems and equipment that require disconnection and/or removal include the primary coolant system, poison injection system, instrumentation, warm waste drain, control rod cooling air system, air shrouds, demineralized water fill system, and the expansion joint between the vessel and the canal. Since the water would have to be drained from the reactor vessel to disconnect these systems, the shielding provided by that water would not be available, thereby raising the radiation levels for the workers working in the annular space as well as the remainder of the reactor building. Because of the difficulty in accessing and removing these systems, as well as the general dose rate in those work areas, it is estimated that these tasks would require a total exposure of 12,000 mrem.

Following the removal of all attached systems and equipment, the vessel and core components must be structurally disconnected from the associated building and structure. The vessel sits on a poured concrete ledge and is attached by a core support ring that is bolted to the concrete ledge. Those bolts would have to be disconnected and are accessible in the annulus. In addition, the lower lateral restraint subassembly would have to be disconnected in the subpile room. In addition, because of the narrow clearance between the vessel support ring and the interior of the annular space, all systems and equipment that obstruct that space must be removed to provide clearance for the vessel removal. This includes the loss of coolant accident test system and other piping systems in the upper annulus, which is the narrowest part of the annular space. The upper annulus is very cluttered with numerous piping intertwined systems that would require removal. Two deck plates that surround the vessel also would require removal and are likely to have to be sized in the annular space to be removed. In addition, many are in relatively high radiation fields that would require shielding. The estimated exposure for these activities is 4,800 mrem.

On the main level, the control rod bridge would have to be removed prior to removal of the vessel, since it obstructs the vertical space above the vessel. The control rod bridge is a large, heavy piece of equipment that would require an independent lift analysis, access analysis, and disposal determination prior to removal.

A lifting fixture must be fabricated and connected to the top of the reactor vessel. A fixture similar to that used to install the vessel would be constructed and attached to existing attachment points. An analysis would be required to ensure that the existing attachment points are strong enough to lift the reactor vessel and core components since they were only used to lift the vessel alone at the time of installation.

Removing the vessel from the building would require either a hole in the roof or removal of the building. It is assumed that the building would remain in place to provide contamination and access control. A preliminary analysis shows that a 25 × 25-ft opening in the roof can be cut without impacting the structural integrity of the building.

Because of the size and weight of the vessel and components (~140,000 lb) and the requirement to reach over the building, a large crane with a long beam would be required. Specifically, the crane would have to have the capability to lift 140,000 lb at a 72-ft radius, and it requires a minimum boom length of 226 ft. The crane would have to be mobilized and assembled on-Site. An analysis of the soil loading capability would be required to ensure that it can support the weight of the crane and load. An evaluation of the integrity of the vessel and components would be required to ensure that they can be pulled together without failure. A lift plan and tie-down plan also would be required.

It is unknown at this time what packaging would be required prior to disposal. At a minimum, the core components would have to be stabilized within the vessel and the entire vessel wrapped. Shipment to the RWMC would require a security escort. After arriving at the RWMC, the vessel and core components would be disposed of in the low-level waste pit.

In summary, the removal of the reactor vessel and core components is a complex and difficult activity. Several issues remain unresolved, including packaging and disposal requirements, reduction of personnel radiation exposure during removal of systems and equipment in the annular space and during disconnection of the vessel from the building structure, and removal of the control rod bridge. It is estimated the worker radiation dose to perform this work alone would be greater than 17,000 mrem.

5.4.3 Scope Summary and Discussion—Removal of All Shielding Lead

It is anticipated that lead to be removed would be placed in waste boxes for ultimate macroencapsulation and disposal at an appropriate repository. It is anticipated that every effort would be made to utilize remote or mechanical material-handling approaches in order to reduce worker risk and radiation exposure. Packaged lead would be removed through facility equipment hatches. Consideration also has been given to creating a new external access through a previous building construction opening. In addition, the 147 lb of cadmium sheeting would be removed coincident with the Fission Product Detection System.

Shielding lead would be removed from the facility in the approximate quantities listed in Table 11.

Table 11. Alternative 3 estimated personnel radiation exposures.

Decommissioning Activity	Hours	Personnel	Total Hours	Dose Rate (mrem/hr)	General Exposure (mrem)[a]	Incremental Exposure (mrem)[b]	Total Exposure (mrem)
Complete all activities included in Alternative 1.	—	—	11,395	—	647	600	1,247
IPT removal							
Cut nozzles.	40	3	120	1	120	—	120
Set container in canal.	10	3	30	0.25	8	—	8
Move IPT.	1	4	4	50	200	—	200
Remove IPT water.	2	3	6	1	6	—	6
Place lid and decon. container.	2	3	6	10	60	—	60
Remove container load on truck.	1	2	2	25	50	—	50
Transport to RWMC.	3	1	3	2	6	—	6
Remove bolts in reactor annulus.[c]							
Remove structural supports and bolts, install and remove temporary shielding, and perform work planning.	120	4	480	10	4,800	—	4,800
Seal reactor vessel penetrations and Reactor Plant Control System piping.[d]							
Disconnect piping, install and remove temporary shielding, and perform work planning after draining the reactor vessel.	120	4	480	25	—	12,000	12,000
Remove reactor vessel.							
Install lifting fixture.	20	4	80	1	80	—	80
Remove reactor vessel.	4	3	12	25	300	—	300
Transport to RWMC.	3	1	3	2	6	—	6
Lead removal[f]							
Cubicle 10							
Mobilization	40	5	200	1	200	—	200
Piping removal packaging and shielding	200	5	1,000	10	10,000	—	10,000
Strainer shielding	260	3	780	5	2,400	—	2,400

Table 11. (continued).

Decommissioning Activity	Hours	Personnel	Total Hours	Dose Rate (mrem/hr)	General Exposure (mrem)[a]	Incremental Exposure (mrem)[b]	Total Exposure (mrem)
Resin column shielding (outer layer)	120	3	360	10	2,400	—	2,400
Resin column shielding (inner layer)	120	3	360	200	—	48,000	48,000
Heat exchanger shielding	20	3	60	10	300	—	300
Miscellaneous	5	3	15	10	150	—	150
Cubicle 13							
Mobilization	40	5	200	1	200	—	200
Piping removal packaging and shielding	40	3	120	10	1,200	—	1,200
Blowdown tank shield wall	120	3	360	5	1,200	—	1,200
Fission Product Detection System cave	80	3	240	5	600	—	600
Shield panels	10	3	30	5	150	—	150
Miscellaneous	5	3	15	5	75	—	75
Incremental lead removal[e]	20	3	60	50	—	3,000	3,000
Sample room	40	3	120	0.5	60	—	60
Reactor annulus	20	3	60	5	300	—	300
Knockout drum room	2	2	4	25	100	—	100
Warm waste	4	2	8	0.25	2	—	2
Hatch Cover 4	2	2	4	0.25	1	—	1
Remove resin columns.							
Remove Cubicle 10 resin columns.	100	3	300	200	—	60,000	60,000
Remove warm waste room resin column.	20	3	60	100	—	6,000	6,000
Totals	—	—	**16,977**	—	**25,621**	**129,600**	**155,221**

a. The dose rate used for general activities in the PBF was based on the average of general radiation fields in the facility of 0 mrem/hr. This general area dose rate is used except for those identified at higher rates.

b. An incremental dose rate is added for the additional radiation exposure from unshielded components as the current shielding is removed. This can be mitigated by temporary shielding.

c. The dose rate used for activities in the annulus and subpile room is assumed to be about 10 mrem/hr on average, although hot spots are present.

d. The incremental dose rate applied is due to activities around the Reactor Plant Control System piping with no water in the reactor basin. Assuming proximity to the core and shielding, the assumed dose rate is 25 mrem/hr from the reactor vessel and other sources.

e. Assumes 10% of lead is removed at increased dose rate.

f. Assumes that lead is removed from Cubicles 10 and 13 at rates of 2,000 and 8,000 lb/day based on a 10-hour day and 60% production hours. Assumes that lead would be staged outside of the radiation area, packaged for shipping and disposal, and removed from the facility at rates of 1,000 and 2,000 lb/day.

IPT = inpile tube
PBF = Power Burst Facility
RWMC = Radioactive Waste Management Complex

5.4.4 Scope Summary and Discussion—Removal of All Resins

The PER-620 resin columns contain an estimated cumulative total of less than 11 Ci, the majority of which is believed to be Cs-137. Resins with radiological contamination in the PER-620 reactor basements include (1) loop cleanup resin in Cubicle 10, (2) two in-service canal cleanup resin columns in the reactor second basement, (3) two out-of-service canal cleanup resin columns stored in the reactor second basement stairwell, and (4) one out-of-service canal cleanup resin column in the warm waste room. The demineralized water system resin columns on the main floor and high-pressure deionized water demineralizer in the first basement of the reactor are nonradiological, nonhazardous waste and are excluded from this scope.

The two loop cleanup resin columns in Cubicle 10 are located near the northeast corner of the room. The columns are approximately 12 × 132 in. The two general alternatives for removal of the resin from Cubicle 10 include (1) rewetting and sluicing of the resin from the columns and (2) removal of the resin and columns as a unit. If the resin is to be sluiced, an investigation must first be completed to verify the integrity of the loop piping pertinent to the sluicing operation. It is believed that the piping system may not be configured in a manner to perform resin sluicing and may need to be reconfigured or repaired to accomplish this purpose. Alternatively, temporary lines might be required to facilitate the sluicing operation.

If sluicing fails or a piping repair is determined to be infeasible, the resin and columns may be removed as integral components after disassembly and removal of the resin column shield wall. The required pipe cutting and removal to gain access for removal of the loop cleanup resin columns could result in an unacceptable radiological dose, estimated at 60,000 mrem for the activity. The loop resin columns are estimated to contain approximately 8 Ci of radiological material. The dose rate associated with the loop cleanup resin columns is approximately 200–400 mrem/hr. Remote or robotic methods would need to be developed to support this removal activity.

The two in-service canal cleanup columns are approximately 24 × 60 in. and weigh approximately 1,200 lb each. These columns are accessible by the overhead crane and could be removed through the existing access hatches. No provisions are present in the column design to allow draining of fluids. These columns do not appear to have provisions for sluicing resin. There is little or no radiological activity associated with these columns.

The two out-of-service canal cleanup columns are of identical design and construction to the service canal cleanup columns. These columns are water filled and weigh approximately 1,200 lb each. The columns are stored in the second basement stairwell, but could be moved under an existing access hatch for removal by the overhead crane. These columns have been estimated to contain approximately 0.55 Ci of radiological material. The contact dose rate associated with these columns is approximately 80 mrem/hr.

The out-of-service canal cleanup resin column in the warm waste room was abandoned in place when the canal cleanup columns described above were brought into service. The column dimensions are approximately 24 × 102 in. While the column is fitted with lifting fixtures, it is not directly accessible by the overhead crane. The current configuration of piping associated with this column is not known. This column does have connections for sluicing and also a flanged top cover. Alternatives for resin removal include sluicing, removal of the top cover and manual removal of the resin, and demolition of the warm waste room's west block wall followed by removal of piping and the resin and column as a unit. The resin is assumed to be dry and caked at present, which may preclude sluicing. Demolition and pipe cutting required to gain access for removal of the warm waste room resin column could result in an unacceptable radiological dose, estimated at 6,000 mrem for the activity. The warm waste room's canal cleanup column is estimated to contain 0.19 Ci of radiological material. The contact dose rate associated with the warm waste room canal cleanup resin column is approximately 200 mrem/hr.

Process knowledge would be applied to characterize the radiological and hazardous constituents of the loop and canal cleanup resins. In cases where process knowledge is not sufficient to generate an isotopic inventory and hazardous waste characterization for a particular resin bed, resins would be sampled and characterized.

With characterization complete, specific disposition paths for the various resins would be identified. Depending on isotopic inventory and hazardous constituency, final disposition paths for removed resins may include the RWMC active pit, ICDF, off-Site disposal, or a combination thereof. If resin stabilization is required, it would be evaluated and executed prior to final disposition.

5.4.5 Effectiveness of Alternative 3

The two subcriteria for evaluating effectiveness are protectiveness and the ability to meet the removal action objectives.

5.4.5.1 Protectiveness of Alternative 3. Alternative 3 would be protective of public health, the community, and the environment when the removal action has been completed, because virtually all of the contaminants present in the PBF reactor building would have been removed and those contaminants remaining (i.e., minor amounts of surface contaminants) would be immobilized in place. The building debris, IPT, reactor vessel, contaminated resins, and shielding lead would be stabilized (as required) and disposed of at the ICDF, RWMC, or other acceptable on-Site disposal facility. This would place most of the contaminant sources in a controlled configuration in the ICDF, which is a landfill specifically designed to prevent access to the contaminants from the surface and to prevent contaminants from reaching the Snake River Plain Aquifer in concentrations that would exceed Idaho groundwater quality standards or risk-based limits.

Immobilization of the remaining minor residual contaminants in the building substructure through addition of grout would inhibit migration of those contaminants to the Snake River Plain Aquifer in amounts that would substantially exceed the removal action objectives. However, the risk assessment in Section 2.5 demonstrates that even without grouting, the remaining contaminants would not pose a threat to the aquifer. During the removal action, the action would be protective of health, the community, and the environment through the use of engineering controls.

During the removal action, the action would be protective of health, the community, and the environment through the use of engineering and work process controls. However, the potential for worker exposure is so high for some removal activities so as to render this alternative impractical.

Worker exposure during implementation of Alternative 3 was estimated by examining the specific individual activities involved in accomplishing the overall tasks and objectives, determining estimated times in which work would be performed in locations with radiation exposure fields, estimating crew sizes, determining overall estimated hours for work to be performed, and using estimated radiation exposure rates based on current facility information and surveys. Buildup and estimated overall personnel exposure results for Alternative 3 are provided in Table 11. Total personnel radiation exposure for this alternative is estimated to be over 155,000 mrem. This level of worker exposure is considered to be unacceptable. With the INEEL administrative control level of 700 mrem/year, at least 222 employees would receive their annual dose implementing this alternative and it alone would be three times the total annual INEEL dose for the entire site in 2003.

In addition to worker radiation exposure, removal of the complete shielding lead inventory identified in Table 9 would introduce substantial worker risk. More specifically, this activity would increase the worker risks identified in Section 5.1.2 over and above those associated with Alternative 2; namely, the risks associated with lead brick handling (airborne lead concentrations; finger, hand, and other injuries; and confined space work) as well as ergonomic and heat-related risks also are described.

Alternative 3 would generally comply with all ARARs. However, the additional worker exposure with no associated risk reduction is inconsistent with the principles of ALARA, as defined in DOE Order 5400.5 and 10 CFR 835. Therefore, conformance to this requirement is an issue. The collective effects of worker radiation exposure for this alternative have not been evaluated, since the full scope of work has not been defined for the time period in which the work would be performed.

The building debris, contaminated reactor, lead shielding, and loose, contaminated particles that would be removed from the PBF reactor building would be stabilized (as required) to meet the disposal facility's waste acceptance criteria.

This alternative would remove all the lead shielding from the PBF reactor building. This lead would become a CERCLA waste requiring management to meet ARARs when it is removed, as it is expected to exceed the limits described in 40 CFR 261.24, "Toxicity Characteristic," of RCRA. The stabilization of the lead through macroencapsulation would result in a waste form that meets the waste acceptance criteria for the ICDF and satisfies the substantive ARAR requirements of the HWMA/RCRA land disposal restrictions.

Hazardous waste determinations would be made (as required) to demonstrate that the building debris, activated components (such as the IPT and reactor vessel), shielding lead, and contaminated resins would meet the disposal facility's waste acceptance criteria. As a CERCLA project, this removal action would not require permits for on-Site activities.

5.4.5.2 Alternative 3—Ability to Achieve Removal Objectives. Alternative 3 would meet the removal action objectives by removing the abovegrade PBF reactor structure (PER-620), water contained in the PBF reactor building (including the reactor vessel) and the activated IPT, the reactor vessel, all of the shielding lead, and contaminated resins. This would be followed by in-place grouting of the remaining building substructure. The removed contaminants and contaminated media would be stabilized (as required) and disposed of at the ICDF, RWMC, or other acceptable disposal facility. The streamlined risk assessment (Section 2.5) demonstrates that the residual contaminant source would not cause the Snake River Plain Aquifer to exceed the Idaho groundwater quality standards or applicable risk-based concentrations in the future.

The removal action would be expected to serve as the final action for the PBF reactor building and the hot waste storage facility. Institutional controls would not be required after the removal action is completed, because the minimal contaminants remaining would be grouted in place, and the protective cover would allow for unrestricted use and unlimited access. These institutional controls would be incorporated into the institutional controls managed under the Record of Decision (DOE-ID 2000).

5.4.6 Implementability of Alternative 3

5.4.6.1 Technical Feasibility of Alternative 3. Alternative 3 presents enormous technical challenges that would not exist with Alternatives 1, 2, or 4 because of the removal of the most difficult portion of the shielding lead, reactor vessel, IPT, and loop cleanup resins (i.e., those materials that were not considered to be practical to be removed in Alternative 2).

Removal of the reactor vessel would require specific engineering controls to allow removal of the vessel and its activated core support structure while minimizing exposure to workers. The reactor vessel is an open-top cylindrical tank made of stainless steel. It is 29 ft deep with an inside diameter of 15 ft and weighs about 100,000 lb. The majority of the activated components in the reactor vessel are the core support structure and internals. Consideration was made to removing just these activated components; however, this subalternative was dismissed as potentially resulting in more personnel exposure than removing the entire vessel. Secondary systems and reactor utility support systems are relatively clean radiologically and may be left in place.

To achieve this, task workers would be required to remain at a safe distance from the reactor vessel as it is lifted from the confines of the reactor pool. In addition, temporary shielding may be used to provide a safe worker environment during this removal process. Structural supports and piping would be cut remotely or by using customized tools to allow workers to remain at a safe distance from the radiation fields. These methods would be evaluated and determinations made based on technology availability and cost vs. practicality criteria. Alternative 3 would be expected to take about 3 to 5 years to implement.

Technical challenges associated with removal of the inner course of shield bricks around the loop cleanup resin columns in Cubicle 10, the loop cleanup resin columns, and the canal cleanup resin column in the warm waste room reside primarily in the management of the radiological dose acquired through the removal process. Combined exposure for the removal of the inner course of shield bricks, the resin columns in Cubicle 10, and the resin column in the warm waste room has been estimated at approximately 114,000 mrem. To reduce the radiological dose received, remote-operated equipment and temporary shielding would be utilized to the extent practical. However, because of inaccessibility of the installations, exclusively remote removal and handling are not feasible. Demolition and removal of radiologically contaminated piping would be required to create equipment access to the resin columns and would result in the disturbance of friable asbestos in addition to an unacceptable dose rate.

5.4.6.2 Availability of Alternative 3. Alternative 3 has major constraints with respect to availability. Removal of the most difficult shielding lead and the loop cleanup resins would result in unacceptably high personnel radiation exposures. Conversely, advanced remote and robotic approaches would need to be developed to remove these materials in a manner that would not result in such high personnel radiation exposures. The equipment necessary to implement the removal action would need to be developed, and it is not commercially available. This alternative does not meet the practicality criteria described in Section 5.1 with respect to removal of all shielding lead, the reactor vessel, and all the contaminated resins.

The ICDF or RWMC would be the assumed location for disposal of the hot waste storage tank (PER-732), the contaminated reactor, lead shielding, and loose, contaminated particles. Selection of the disposal site would depend on the waste characteristics and the waste acceptance criteria of the disposal site. Contaminated debris would be disposed of at the ICDF, RWMC, or the CFA Landfill Complex, depending on the waste characteristics and the waste acceptance criteria of each facility. Lead waste generated in Alternative 3 would be sent to an appropriate disposal facility for macroencapsulation prior to disposal. These facilities would be available during implementation of the removal action. The ICDF evaporation ponds or the TRA evaporation ponds are the assumed disposal location for the contaminated water. At least one of the two facilities is expected to be available during implementation of the removal action.

5.4.7 Administrative Feasibility of Alternative 3

Administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and adjacent to the PBF with disposal at the ICDF Complex, TRA evaporation ponds, RWMC, or other suitable disposal facility. As a CERCLA project, this removal action would not require permits for on-Site activities. No easement issues would exist. Right-of-way issues would not exist for trucking the water from PBF to the TRA evaporation ponds or water and other waste to ICDF facilities, because the trucks would not cross or travel along public highways. However, waste that would be sent to the RWMC for disposal would cross public highways, and U.S. Department of Transportation regulations would apply. There would be no impacts on adjoining properties from implementation of Alternative 3.

For Alternative 3, no institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.

5.4.8 Cost of Alternative 3

The total escalated cost to implement Alternative 3 is $17.4 million. In net present value, this equates to $17.0 million. The capital costs include costs for the isolations, deactivation, removal of all shielding lead, removal and disposal of the IPT and reactor vessel, grout placement, demolition of the abovegrade structures, construction of the cover, waste disposal, and installation of two monitoring wells. No monitoring would be required for this alternative.

5.4.9 Evaluation Summary—Alternative 3

Alternative 3 is protective relative to the defined public health and community, environment, and ARAR compliance effectiveness criteria. It is not protective of the workers, since the associated radiation exposure is extremely high (over three times the dose for the entire site for 2003), and it would drive radiation exposures to maximum values for over 200 workers. The additional worker exposure with no associated risk reduction is inconsistent with the principles of ALARA, as defined in DOE Order 5400.5 and 10 CFR 835. Therefore, conformance to this requirement is an issue.

Alternative 3 is considered to be unimplementable because of the resource constraints associated with high radiation exposures. Conversely, development of the sophisticated technology for remote or robotic removal of the entire nonradiological and radiological inventory is not practical.

Alternative 3 represents the highest net present value total cost among the alternatives that provide a final action and would be $8,600,000 more expensive than Alternative 1.

The groundwater pathway risk assessment demonstrated that environmental risk is acceptable with no removal of nonradiological or radiological inventory. There are no net benefits of Alternative 3 in further reducing this risk by removing this entire inventory, which might offset the higher worker exposure risk or cost, even if this alternative was determined to be implementable or protective of the workers. Additional comparative analysis detail is provided in Section 6.

5.5 Alternative 4

Alternative 4 would place the PBF reactor building in interim safe storage. This alternative includes the necessary modifications to the PER-620 facility to ensure that PER-620 is safely stored until the removal of components and materials is initiated at the end of the storage period, as deemed necessary at that time. Alternative 4 would include the removal and disposal of the abovegrade PBF reactor building at the ICDF, RWMC, or CFA industrial landfill, depending on the waste type. Water in the canal, around the reactor, and in various tanks and piping would be removed and disposed of at the ICDF or TRA evaporation ponds or other suitable disposal facility, depending on availability and waste acceptance criteria.

Alternative 4 would include the demolition of the entire abovegrade structure of PER-620 and erection of a new roof system over the PER-620 basement foundation walls to enclose the facility within a weather-protected containment. All existing penetrations of the PER-620 foundation walls would be closed to prevent animal intrusion and water in-leakage into the final safe storage structure. A single access door would be provided to allow periodic inspection of the facility.

This alternative would require continued surveillance and maintenance of the facility to allow the higher radiation levels in the activated and contaminated components and materials to decay to more manageable levels at which time the DOE-ID, EPA, and DEQ would determine the final disposition strategy. A RCRA storage permit and monitoring would be required for this alternative. In contrast to Alternatives 1, 2, and 3, Alternative 4 is not a final action.

5.5.1 Effectiveness of Alternative 4

This alternative results in the continued surveillance and maintenance of the PBF reactor building in a "cocooned" state. Although the abovegrade portion of the PBF reactor building would be removed and disposed of, the substructure would be left as is with a new roof. The two subcriteria for evaluating effectiveness are protectiveness and the ability to meet the removal action objectives.

5.5.1.1 Protectiveness of Alternative 4. Alternative 4 would be protective of public health, the community, and the environment when the removal action has been completed, because the abovegrade portion of the PBF reactor building and water in storage would be removed and disposed of and contaminants present in the PBF reactor building's substructure would be isolated through the installation of a new roof. The new roof over the PBF substructure would prevent infiltration of rainwater and snowmelt through the structure and thereby inhibit migration of contaminants to the Snake River Plain Aquifer in amounts that would exceed the removal action objectives. During the removal action, the action would be protective of health, the community, and the environment through the use of active engineering controls.

Although protective, Alternative 4 is a temporary action that would require additional action at a later date, to place the PBF reactor building in a final, protective configuration. The objective of interim safe storage is to allow the short-lived radionuclides to decay enough to significantly reduce worker exposure associated with the eventual final action.

Safe storage conditions would be such that (1) interim inspection could be limited to a 5-year frequency, (2) containment would ensure that releases to the environment are not credible under normal design basis conditions, (3) structural integrity of foundation walls' penetration closures would be at least equivalent to the existing wall design, and (4) new roof system would be adequate to eliminate the need to replace the roof during the intended facility safe storage lifetime, which is estimated at 75 years.

Worker exposure during implementation of Alternative 4 was estimated by examining the specific individual activities involved in accomplishing the overall tasks and objectives, determining estimated times in which work would be performed in locations with radiation exposure fields, estimating crew sizes, determining overall estimated hours for work to be performed, and using estimated radiation exposure rates based on current facility information and surveys. Buildup and estimated overall personnel exposure results for Alternative 4 are provided in Table 12. All radiation exposure associated with this alternative is estimated to be received in performing future surveillance and maintenance. This level of worker exposure is considered to be unacceptable.

Engineering controls would be required for the new cover over the substructure to preclude personnel admittance above the reactor vessel, which would be essentially open at the top with no shielding over the activated metal of the core support structure and possibly the IPT. Dose rate estimates would be needed to determine what, if any, access limitations would be necessary. Alternative 4 would comply with all ARARs.

Table 12. Alternative 4 estimated personnel radiation exposures.

Decommissioning Activity	Hours	Personnel	Total Hours	Dose Rate (mrem/hr)	General Exposure (mrem)[a]	Incremental Exposure (mrem)[b]	Total Exposure (mrem)
Remove abovegrade PBF reactor building.[c]							
Internal D&D	320	5	1,600	0	—	—	—
Annex D&D	160	5	800	0	—	—	—
External D&D	600	5	3,000	0	—	—	—
Drain and dispose of reactor, canal, and piping water.[c]							
Equipment setup and remove and transport reactor vessel water.	200	3	600	0	—	—	—
Equipment setup, mockup and plan, and remove and transport primary coolant piping water.	160	3	480	0	—	—	—
Fire protection	80	3	240	0	—	—	—
Construct a new structure utilizing the existing foundation walls.	323	5	1,617	0	—	—	—
Isolate piping and electrical services.							
Isolate Motor Control Center loads and verify zero energy.	65	3	195	0	—	—	—
Cut and cap piping inside basement wall.	144	5	720	0	—	—	—
Cut and cap piping and conduit outside basement wall.	32	5	160	0	—	—	—
Work planning and field verification	20	4	80	0	—	—	—
Construct forms/grout exterior wall penetrations.							
Pipe grouting	36	5	180	0	—	—	—
Electrical grouting	12	5	60	0	—	—	—
Perform 90-year surveillance and maintenance.	1,563	6	9,380	0.25	2,345	—	2,345
Totals	—	—	**19,112**	—	**2,345**	—	**2,345**

5.5.1.2 *Alternative 4—Ability to Achieve Removal Objectives.* Alternative 4 would meet the removal action objectives by removing the abovegrade PBF reactor structure (PER-620) and water contained in the PBF reactor building and in the hot waste storage tank (PER-732) and placing the remaining substructure and its contents into interim safe storage. Alternative 4 would require active engineering controls and surveillance and maintenance until such time that the final action is taken to place the facility in a safe, permanent configuration. Alternative 4 is not a final action, but would meet short-term objectives. Specific actions would need to be revisited at some time in the future following implementation of this short-term alternative.

5.5.2 Implementability of Alternative 4

5.5.2.1 Technical Feasibility of Alternative 4. Alternative 4 would be technically feasible. The removal of the abovegrade portion of the PBF reactor building would be accomplished using well-established D&D methods. The water removal and disposal also would be implemented using established D&D practices. A significant technical challenge would be maintaining worker exposures ALARA during decontamination activities and after water has been removed from the PBF reactor building. The application of fixatives to the walls and floor of the building substructure might be necessary.

Alternative 4 would include the removal of all water remaining in the PER-620 facility as identified in Alternative 1, except with the addition of removal of the water in the reactor vessel. Water in the reactor vessel would be removed using engineering controls to limit the radiation exposure to workers. Removal of the reactor vessel water would require coordination with demolition of the aboveground structure and erection of the new roof system because of the loss of shielding the water provides in the reactor vessel.

Implementation of Alternative 4 would include the installation of engineering controls and a monitoring system sufficient to preclude the necessity of entering the structure except on a low-frequency basis, such as every 5 years. The ventilation design would provide for adequate exhaust to remove radon and reduce contamination levels within the facility in less than 24 hours and would provide adequate air turnover to allow the presence of workers for up to 12-hour periods during surveillance inspections and maintenance activities.

This alternative would provide for the decontamination of equipment and structural components to the extent possible using ALARA practices. The areas with the highest contamination levels are in Cubicles 10 and 13, the subpile room, the knockout room, the sample room, and the hot/warm waste room. These areas would require the most rigorous decontamination activities. The lead shielding would remain in place to reduce radiation exposure to the workers during decontamination activities.

Other aspects of Alternative 4 that would be technically feasible include providing a lighting system designed to provide adequate illumination for performance of surveillance and maintenance activities and installing an access door for surveillance and maintenance activities. The door would be designed such that opening the door from the outside would require cutting or grinding the retaining mechanisms, small animal intrusion is prevented, and deterioration would be minimized such that the facility would not require maintenance more frequently than every 5 years. Alternative 4 would be expected to take about 1 year to implement.

5.5.2.2 Availability of Alternative 4. Alternative 4 has few constraints with respect to availability. The equipment necessary to implement the removal action is commercially available or is currently available at the INEEL. Personnel and services also would be available. Alternative 4 would require limited personnel and services to implement the removal action. Laboratory testing capabilities exist on-Site and would be available for the removal action.

The ICDF and RWMC would be the assumed locations for disposal of the water, waste, and much of the debris. Pending finalization of the liquid effluent treatment facility at the ICDF, it is assumed that the PBF water would meet the waste acceptance criteria. If the ICDF is unavailable or unable to accept PBF reactor building water, the TRA evaporation ponds may be used to treat and dispose of the water. The TRA evaporation ponds are expected to be available, but their use would require coordination with TRA operations. To accelerate the removal of water from certain small tanks, smaller quantities of water may be shipped to another suitable disposal facility for treatment and disposal.

5.5.2.3 Administrative Feasibility of Alternative 4. Administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and adjacent to the PBF with disposal at the ICDF Complex, TRA evaporation ponds, RWMC, or another suitable disposal facility. As a CERCLA project, this removal action would not require permits for on-Site activities. No easement issues would exist. Right-of-way issues would not exist for trucking the water from PBF to the TRA evaporation ponds or water and other waste to ICDF facilities, because the trucks would not cross or travel along public highways. However, if waste was sent to the RWMC for disposal, it would cross public highways, and U.S. Department of Transportation regulations would apply. There would be no impacts on adjoining properties from implementation of Alternative 4.

The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For Alternative 4, active engineering controls and institutional controls would be required after completion of the removal action to maintain protectiveness until final action is taken. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.

5.5.3 Cost of Alternative 4

The total escalated cost to implement Alternative 4 is $15.5 million. In net present value, this equates to $5.6 million. The capital costs include costs for the isolations, deactivations, demolition of the abovegrade structures, construction of the roof, and waste disposal. A 100-year surveillance and maintenance period is assumed. The surveillance and maintenance costs included in the total costs above are estimated at $12.1 million (or $2.2 million in net present value).

5.5.4 Evaluation Summary—Alternative 4

Alternative 4 is protective relative to the defined public health and community, environment, workers, and ARAR compliance effectiveness criteria. Alternative 4 is considered to be implementable. Alternative 4 represents the lowest net present value total cost, but it is not a final action.

The groundwater pathway risk assessment demonstrated that environmental risk is acceptable with no removal of nonradiological or radiological inventory. Additional comparative analysis detail is provided in Section 6.

6. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

A comparative analysis of the four remaining alternatives is presented in Table 13.

7. RECOMMENDED REMOVAL ACTION ALTERNATIVE

The DOE-ID compared the alternatives described in Sections 4 and 5 and prefers Alternative 1, because it reduces the potential risk to the aquifer, satisfies the removal action objectives, protects site workers taking the action, complies with regulations, and is cost effective. It can be implemented relatively rapidly (within 1 year), and it provides a safe, stable, and permanent configuration. The DOE-ID also considers Alternative 2 reasonable within the range of acceptable alternatives, because it reduces the potential risk to the aquifer, satisfies the remedial action objectives of the Record of Decision (DOE-ID 2000), and complies with regulations. Alternative 2 is not preferred because it does not protect the workers taking the action to the same degree as provided by Alternative 1, because the costs are greater than those of Alternative 1, and because it offers no commensurate risk reduction benefit to human health and the environment.

Alternative 3—like Alternatives 1 and 2—reduces potential risk to the aquifer, satisfies the removal action objectives, and complies with regulations, but it is considered impractical and unacceptable because it is much more costly and has much greater worker risk than Alternatives 1 or 2. Although Alternative 4 places the PBF reactor building in a safe and stable configuration, it is not preferred because it is a temporary action and as such, it simply delays final action to a future date.

Under Alternative 1, the abovegrade PBF reactor building (PER-620) would be removed and disposed of at the ICDF, RWMC, or CFA industrial landfill, depending on the waste type. Water in the canal, around the reactor, and in various tanks and piping would be removed and disposed of at the ICDF or TRA evaporation ponds or other suitable disposal facility, depending on availability and waste acceptance criteria. The remaining substructure (including the reactor, associated lead shielding, contaminated resin beds, and other contaminated contents) would be stabilized in place with a grout. Following grouting, a performance-based cover would be placed over the facility.

This removal action would reduce the risk to the Snake River Plain Aquifer by inhibiting the release and migration of contaminants currently in the PBF reactor building to the aquifer. The action also would ensure that risks posed by contaminants grouted in place in the facility do not exceed acceptable levels. Although the PBF reactor was not specifically addressed in the Record of Decision (DOE-ID 2000), the action is consistent with the remedial action objectives for soil sites in the Record of Decision (DOE-ID 2000) and with past actions taken on reactor facilities in the PBF area.

7.1 Compliance with Environmental Regulations, Including Those that are Applicable or Relevant and Appropriate Requirements

Both Alternatives 1 and 2 would result in the disposal of lead and 147 lb of cadmium sheeting (associated with the Cubicle 10 Fission Product Detection System) within the existing subsurface structure at PBF. Entombment of these materials by filling the void spaces of the subsurface structure with grout, as in Alternatives 1 or 2, would be an act of "discarding" the materials. At that time, the materials would become solid waste because of the toxic characteristics of lead and cadmium; this disposal would need to meet the requirements for closure of a hazardous waste landfill.

Those requirements include the general standards set out at IDAPA 58.01.05.008 (40 CFR 264.111), including the following:

- Minimizes the need for further maintenance

- Controls, minimizes, or eliminates—to the extent necessary to protect human health and the environment—postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.

In addition, IDAPA 58.01.05.008 (40 CFR 264.310) and IDAPA 58.01.05.009 (40 CFR 265.310) provide specific standards for landfill closures. Subsection (a) requires the final cover be constructed to:

1. Provide long-term minimization of migration of liquids through the closed landfill
2. Function with minimum maintenance
3. Promote drainage and minimize erosion or abrasion of the cover
4. Accommodate settling and subsidence so that the cover's integrity is maintained
5. Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoil present.

Subsection (b) lists postclosure requirements, including establishing and operating a groundwater monitoring system.

Both Alternatives 1 and 2 involve entombment of some or all of the remaining lead and cadmium sheeting in the subsurface structure, using grout, and capping of the resulting monolith with a landfill cover. These actions would meet the closure performance standards and cover design requirements of a closed HWMA/RCRA landfill. In both Alternative 2 (which would involve removal of a portion of the lead and cadmium) and Alternative 1 (in which the existing materials would be left in place), DOE-ID has determined that the disposed lead and cadmium will not cause an unacceptable risk to human health or the environment via the exposure pathways to groundwater, direct exposure, inhalation, ingestion, or to ecological receptors. In particular, because the total risk to the environment from such disposal in place is very low, the removal of lead and cadmium under Alternative 2 does not materially reduce the risk to human health or the environment from possible leaching of lead or cadmium beyond the already low risk presented by Alternative 1.

The applicable HWMA/RCRA closure standards for landfills do not require the removal of hazardous waste from disposal units, but are instead focused on prevention of releases from the disposed hazardous waste. That is, removal of a portion of the lead and cadmium prior to grouting and disposal is not required by the HWMA/RCRA landfill closure standards. Therefore, both Alternatives 1 and 2 are consistent with the HWMA/RCRA landfill closure standards.

Section 121 of CERCLA (42 USC § 9621) requires the responsible CERCLA implementing agency (in this case, DOE-ID) to ensure that the substantive standards of HWMA/RCRA and other applicable laws will be incorporated into the Federal agency's design and operation of its long-term remedial actions and, to the extent practicable, into its more immediate removal actions as well.

The applicable landfill closure standards can be met in one of two ways. One option for DOE-ID is to apply to DEQ for a postclosure permit, which would include the substantive requirements in the text of the permit. The issuance of such a permit by DEQ would in that case be subject to all of the usual procedural mechanisms and processes. A second option for DOE-ID is to include the substantive standards in the design and execution of its removal action, pursuant to Section 121(e)(1) of CERCLA. Congress enacted 42 USC § 9621(e)(1) in the "Superfund Amendments and Reauthorization Act of 1986 (SARA)" (Public Law 99-499) in order to allow CERCLA removal actions and remedial actions (if they are conducted "onsite" at a facility listed on EPA's Superfund National Priorities List) to be expeditiously carried out without the need to obtain permits.

In short, CERCLA requires DOE-ID to meet, to the full extent practicable, all of the substantive standards that apply to the postclosure care of a landfill, but DOE-ID can meet those standards by either (1) following the typical process of obtaining a postclosure permit for this landfill or (2) using the authority of § 121(e)(1) to incorporate the standards into the CERCLA removal action and its documents. In either case, the HWMA/RCRA landfill closure standards will be met, including long-term monitoring and maintenance of containment features of the landfill.

Table 14 lists the proposed ARARs that have been identified for this removal action. These ARARs are a compilation and expansion of the ARARs identified in the Record of Decision (DOE-ID 2000). The ARARs list is based on several key assumptions:

- Currently, the water in the facility provides shielding for the reactor and activated metals—all with significant radioactivity—as well as radioactive contamination adhering to and/or embedded in the interior canal surfaces.

- Management of CERCLA waste generated during the removal action would be subject to meeting the waste acceptance criteria of the receiving facility, whether that facility is an on-INEEL facility (such as the ICDF, RWMC, INEEL Landfill Complex at CFA) or an off-INEEL facility. The ICDF is the preferred location for disposal of contaminated CERCLA waste that would be generated during implementation of the removal action and would be handled in accordance with the ARARs identified in Table 14.

- Land disposal restrictions are applicable to CERCLA hazardous waste generated under this removal action.

- If decontamination liquids are generated, they would be handled in the same manner as the contaminated water removed from the PBF canal, tanks, and piping.

- Debris generated during demolition of the PBF reactor building might have paint that contains PCBs. If encountered, such waste may trigger substantive requirements of the Toxic Substances Control Act (15 USC § 2601 et seq.). Lead-contaminated paint might be generated during demolition, which would be subject to the substantive requirements of RCRA hazardous waste regulations. This waste is planned for disposal at the ICDF, unless it can be demonstrated that it is eligible for disposal as solid waste at the CFA Landfill Complex. The PCB-containing light ballasts would be removed from the building prior to this removal action under DOE-ID's Deactivation Program.

- Asbestos-containing material would be encountered during demolition. This waste would be subject to certain asbestos regulations and would be acceptable for disposal at the ICDF or, if not radiologically contaminated, at the CFA Landfill Complex. Asbestos contained in the PBF substructure would be left in place. This substructure asbestos may be managed in place in accordance with asbestos disposal site requirements of 40 CFR 61.154, "Standard for Active Waste Disposal Sites."

- Lead shielding, in various forms, would be generated as a waste during demolition of the abovegrade portion of the PBF reactor building. This lead would be recycled to the extent possible but otherwise disposed of at the ICDF or another suitable disposal facility after macroencapsulation to meet land disposal restrictions. Lead in the building substructure would be grouted in place.

- Mercury located in about 100 mercury fluorescent lamps in the basement would be removed prior to this removal action under DOE-ID's Deactivation Program, as would the mercury-containing electrical switches and lights in the abovegrade structure. No mercury is expected to be present in the building substructure at the start of the removal action.

Table 13. Comparative analysis of alternatives.

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Protectiveness	Alternative 1 would be as protective as Alternatives 2 or 3 after completion of the removal action. Contamination would remain in the substructure, including the reactor and its lead shielding, but that contamination would be immobilized in place through the placement of grout.	Alternative 2 would be as protective as Alternative 3 after completion of the removal action. Contamination would remain in the substructure, including the reactor and its lead shielding, but that contamination would be immobilized in place through the placement of grout.	Of the alternatives, Alternative 3 would have the greatest protectiveness once the removal action is completed, because more of the contaminants would be removed from the facility than in the other alternatives. The contaminants would then reside—depending on waste characteristics—in the ICDF (which is a monitored landfill) or the RWMC (another monitored landfill) or at the CFA Landfill Complex (an industrial landfill) and/or at an approved off-Site disposal site.	Alternative 4 would be the least protective after completion of the removal action, because, as interim safe storage, the building substructure relies on active engineering and institutional controls to prevent exposure. The new roof and the facility would require surveillance and maintenance. However, as long as the engineering and institutional controls do not fail, Alternative 4 would be protective.
	The streamlined risk assessment demonstrates that leaving these contaminants in place would not pose unacceptable risk through the groundwater pathway, nor would it cause the Idaho Ground Water Quality standards to be exceeded in 2095 and beyond. Grouting of the facility after removal of the aboveground structure would prevent unacceptable direct exposures at the surface or to a potential intruder.	The streamlined risk assessment demonstrates that leaving these contaminants in place would not pose unacceptable risk through the groundwater pathway, nor would it cause the Idaho Ground Water Quality standards to be exceeded in 2095 and beyond. Grouting of the facility after removal of the aboveground structure would prevent unacceptable direct exposures at the surface or to a potential intruder.	With the removal of most of the key contaminants from the facility, this alternative would pose the least threat to the aquifer. Grouting of the facility after removal of major contaminated components and the aboveground structure would prevent unacceptable direct exposures at the surface. Alternative 3 would be the most protective in terms of surface exposure and threat to the aquifer, because it would remove the primary contaminant sources and place those sources in a monitored landfill or landfills at other locations on the INEEL.	Leaving the contaminants in place while the facility is under active surveillance and maintenance would not pose unacceptable risk through the groundwater pathway nor would it cause the Idaho Ground Water Quality standards to be exceeded. The roof would prevent water infiltration, which would inhibit the release and subsequent transport of contaminants toward the aquifer. The roof and active institutional controls would prevent unacceptable direct exposures at the surface. Alternative 4 would be the least protective in terms of surface exposure and threat to the aquifer, because it would be a temporary measure that relies

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
				heavily on active engineering and institutional controls to prevent releases from the facility.
Protectiveness	Worker exposure is estimated to be 1,247 mrem.	Worker exposure is estimated to be 9,335 mrem. This is approximately 20% of the FY 2003 total exposure at the INEEL.	Worker exposure is estimated to be 155,221 mrem. This is approximately three times the FY 2003 total exposure at the INEEL.	Worker exposure is estimated to be 2,345 mrem.
	Alternative 1 would be best among the alternatives in protection of workers. All alternatives would pose the same worker risk associated with the removal and disposal of the abovegrade portion of the PBF reactor building and contaminated water. Worker risk would be less than Alternatives 2 or 3 because of the reduced radiation exposure and other worker risks associated with leaving the inpile tube, reactor, shielding lead, and other radionuclides in place prior to grouting. Worker risk also would be less than Alternative 4, because the contaminants in the substructure would be grouted in place, thereby preventing worker exposure to the reactor, the contaminated items, and the fixed contamination on the substructure walls and floors.	Alternative 2 would be ranked second among the four alternatives in protection of workers. All alternatives would pose the same worker risk associated with the removal and disposal of the abovegrade portion of the PBF reactor building and contaminated water. Worker risk would be greater than Alternatives 1 or 4, because most of the shielding lead would be removed prior to grouting. Worker risk also would be less than Alternative 3 because much of the contaminants in the substructure would be grouted in place, thereby preventing worker exposure to the reactor, the contaminated items, and the fixed contamination on the substructure walls and floors.	Alternative 3 would have the lowest protectiveness in terms of worker exposure and risk. Alternative 3 would have the highest worker exposure because of removal of the inpile tube, reactor, resins, shielding lead, and other radionuclide inventories to be removed from the building substructure.	Alternative 4 would be the second most protective in terms of worker exposure. Worker exposure would be less than Alternative 2 or 3, because the inpile tube, reactor, shielding lead, and other radionuclides would be left in place. Worker exposure would be greater than Alternative 1 because of the years of surveillance and maintenance that would be required before final action is taken. In addition, with the removal of water from the building substructure, the shielding provided by that water would no longer exist, which could result in the need to apply fixatives to the walls and floors of the building substructure, thereby resulting in additional worker exposure during application of the fixative.

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Protectiveness	Nonradiological worker risk—As compared to Alternatives 2 and 3, Alternative 1 would result in lower risk of injury and illness to employees because no materials would be removed from the substructure.	Nonradiological worker risk—Alternative 2 presents more risk of injury and illness to workers due to handling lead in PPE in restricted areas, heat stress, and other ergonomic effects.	Nonradiological worker risk—Alternative 3 presents the highest risk of serious injury and illness to workers.	Nonradiological worker risk—Alternative 4 would present the lowest nonradiological risk to the workforce. This alternative limits worker exposure more than the other alternatives while maintaining a vigilant stewardship program.
	Alternative 1 would have the least risk of a release to the air during implementation of the removal action, because Alternative 1 would leave contaminated items in place and grout the building substructure without requiring worker entry into the most highly contaminated rooms.	Alternative 2 would have the second-greatest risk of a release to the air during implementation of the removal action, because it includes only partial removal of contaminated materials from the facility.	Alternative 3 would have the greatest risk of a release to the air in implementation because of removal of greater amounts of contaminated materials that would be handled during the removal action.	Alternative 4 would have about the same risk of a release to the air during implementation of the removal action as Alternative 1. In contrast to Alternatives 1, 2, and 3, it would not involve grouting of the substructure. However, with the removal of water from the building substructure, there could be a need to apply fixatives to the walls and floors of the building substructure to prevent an air release.
Ability to achieve remedial objectives	Alternative 1 would achieve the removal action objectives, meeting the requirement for protectiveness of human health and the environment.	Alternative 2 would achieve the removal action objectives, meeting the requirement for protectiveness of human health and the environment.	Alternative 3 would achieve removal action objectives, meeting the requirement for protectiveness of human health and the environment.	Alternative 4 would achieve the removal action objectives, meeting the requirement for protectiveness of human health and the environment. However, placing the facility in interim safe storage would be a temporary measure, and additional action would be required in the future to place the facility in a safe, final configuration.

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Ability to achieve remedial objectives	Alternative 1 would require institutional controls, because contamination, although immobilized, would be left in place in the building substructure. Postclosure monitoring would be required for this alternative.	Alternative 2 would require institutional controls, because contamination, although immobilized, would be left in place in the building substructure. Postclosure monitoring would be required for this alternative.	Alternative 3 would require institutional controls, because some contamination, although immobilized, would be left in place in the building substructure. The amount of contaminated material remaining in the substructure would be much less than that remaining under Alternative 1.	Alternative 4 would require active engineering controls and institutional controls, because significant contamination in the building substructure would be left in place. The surveillance and maintenance requirements would be much more extensive than for the other alternatives.
Technical feasibility	Alternative 1 would present few if any technical challenges.	Alternative 2 would be technically feasible, but presents technical challenges that would not exist with Alternatives 1 or 4 because of the removal of the inpile tube, much of the lead shielding, and some of the contaminated resins from the PBF substructure.	Alternative 3 would be the most difficult to implement from a technical perspective. The removal of all the lead shielding would require sophisticated remote/robotic applications to avoid the excessive radiation exposures discussed above. Such equipment is not commercially available and would need to be developed. Such equipment has long lead times and is very expensive. Furthermore, implementation of the removal action using this technology would be extremely slow, increasing operating costs.	Alternative 4 would be the second most technically feasible, nearly as simple to implement as Alternative 1. The technical challenges associated with the removal of the abovegrade portion of the PBF reactor building would be the same across alternatives. In contrast to Alternatives 2 or 3, it would not include the technical challenges associated with the removal of the reactor, lead shielding, and other materials from the substructure or the installation of a soil cover.
	Alternative 1 would require about 1 year to implement.	Alternative 2 would include the removal of all water remaining in the PER-620 facility as identified in Alternative 1 with the addition of the water in the reactor vessel. Water in the reactor vessel would be removed using engineering controls to limit the radiation exposure to workers.	Alternative 3 would require about 3 to 5 years to implement.	In contrast to Alternative 1, it would not require grouting of the substructure or installation of a soil cover. However, Alternative 4 would include technical challenges involved with the removal of water from the reactor vessel and the installation of a fixative on the substructure walls and floors. Therefore, Alternative 4 would be

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
		The removal of shielding lead is technically feasible, but would require complex engineering and work process controls to minimize worker exposure. Alternative 2 would require about 2 years to implement.		slightly less technically feasible than Alternative 1. Alternative 4 would require about 1 year to implement.
Availability	Alternative 1 would be equivalent to Alternatives 2 and 4 in terms of availability, as the equipment and personnel would be available, and less waste would be transported to disposal facilities than for Alternative 2 or 3. Alternative 1 would require the availability of the ICDF for the disposal of debris; the ICDF, TRA evaporation ponds, or other suitable disposal facility for contaminated water; the RWMC for certain radioactive waste; and the CFA Landfill Complex for industrial waste. As long as the waste generated meets the facility's waste acceptance criteria, there should be no issue with the availability of these INEEL disposal facilities.	Alternative 2 would be equivalent to Alternatives 1 and 4 in terms of availability, as the equipment and personnel would be available, and less waste would be transported to disposal facilities than for Alternative 3. Alternative 2 would require the availability of the ICDF for the disposal of debris; the ICDF, TRA evaporation ponds, or other suitable disposal facility for contaminated water; the RWMC for certain radioactive waste; and the CFA Landfill Complex for industrial waste. As long as the waste generated meets the facility's waste acceptance criteria, there should be no issue with the availability of these INEEL disposal facilities.	The least availability is associated with Alternative 3, which would require an unacceptably high amount of personnel resources to spread radiation exposures. Conversely, the sophisticated remote/robotic applications needed to perform the work without incurring these high radiation exposures would not be readily available. Alternative 3 would require the availability of the ICDF for the disposal of debris; the ICDF, TRA evaporation ponds, or other suitable disposal facility for contaminated water; the RWMC for certain radioactive waste; and the CFA Landfill Complex for industrial waste. As long as the waste generated meets the facility's waste acceptance criteria, there should be no issue with the availability of these INEEL disposal facilities.	Alternative 4 would be equivalent to Alternative 2 in terms of availability, as the equipment and personnel would be available, and less waste would be transported to disposal facilities than for Alternative 2. Alternative 4 would require the availability of the ICDF for the disposal of debris; the ICDF, TRA evaporation ponds, or other suitable disposal facility for contaminated water; the RWMC for certain radioactive waste; and the CFA Landfill Complex for industrial waste. As long as the waste generated meets the facility's waste acceptance criteria, there should be no issue with the availability of these INEEL disposal facilities.

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Alternative 1 would require treatment of small volumes of lead waste from the abovegrade structure, utilizing macroencapsulation prior to disposal at an appropriate repository.	Alternative 2 would require treatment of large volumes of lead waste from the abovegrade structure, utilizing macroencapsulation prior to disposal at an appropriate repository.	Alternative 3 would require treatment of large volumes of lead waste from the abovegrade structure, utilizing macroencapsulation prior to disposal at an appropriate repository.	Alternative 4 would require treatment of small volumes of lead waste from the abovegrade structure, utilizing macroencapsulation prior to disposal at an appropriate repository.
Administrative feasibility	For all alternatives, administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and near the PBF with disposal at the ICDF and ponds, TRA evaporation ponds, and/or the RWMC. As a CERCLA project, this removal action would not require permits for on-Site activities. Similarly, no easement or right-of-way issues would exist. There would be no impacts on adjoining properties from implementation of this alternative.	For all alternatives, administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and near the PBF with disposal at the ICDF and ponds, TRA evaporation ponds, and/or the RWMC. As a CERCLA project, this removal action would not require permits for on-Site activities. Similarly, no easement or right-of-way issues would exist. There would be no impacts on adjoining properties from implementation of this alternative.	For all alternatives, administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and near the PBF with disposal at the ICDF and ponds, TRA evaporation ponds, and/or the RWMC. As a CERCLA project, this removal action would not require permits for on-Site activities. Similarly, no easement or right-of-way issues would exist. There would be no impacts on adjoining properties from implementation of this alternative.	For all alternatives, administrative feasibility includes an evaluation of the permits required, easements or right-of-ways required, impacts on adjoining properties, and the ability to implement institutional controls. The removal action would be conducted on the INEEL, at and near the PBF with disposal at the ICDF Complex, TRA evaporation ponds, and/or the RWMC. As a CERCLA project, this removal action would not require permits for on-Site activities. Similarly, no easement or right-of-way issues would exist. There would be no impacts on adjoining properties from implementation of this alternative.

Table 13. (continued).

Criterion	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For all alternatives, institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.	The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For all alternatives, institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.	The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For all alternatives, institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.	The INEEL has the ability to establish and maintain institutional controls through its CERCLA program. For all alternatives, institutional controls would be required after completion of the removal action to maintain protectiveness. Before and during the removal action, the existing institutional controls at PBF would restrict access and prevent exposure.
Overall practicality	This alternative is considered to be practical, relative to the criteria provided in Section 5.1.	This alternative is considered to be marginally practical, relative to the criteria provided in Section 5.1.	This alternative is not considered to be practical, relative to the criteria provided in Section 5.1.	This alternative is considered to be practical, relative to the criteria provided in Section 5.1.
Capital costs (escalated)	$6.4 million	$10.6 million	$17.4 million	$3.4 million
O&M costs (escalated)	$9.0 million	$9.0 million	0	$12.1 million
Total escalated cost	$15.4 million	$19.6 million	$17.4 million	$15.5 million
Net present value total cost	$8.4 million	$12.4 million	$17.0 million	$5.6 million
Cost ranking	1	2	3	Not ranked

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFA = Central Facilities Area
FY = fiscal year
ICDF = INEEL CERCLA Disposal Facility
INEEL = Idaho National Engineering and Environmental Laboratory
O&M = operations and maintenance
PBF = Power Burst Facility
PPE = personal protective equipment
RWMC = Radioactive Waste Management Complex
TRA = Test Reactor Area

Table 14. Summary of applicable or relevant and appropriate requirements for the Power Burst Facility non-time critical removal action.

Requirement (Citation)	ARAR Type	Comments
Clean Air Act and Idaho Air Regulations		
"Toxic Substances," IDAPA 58.01.01.161	A	Applies to the building demolition and waste handling activities.
<10 mrem/yr, 40 CFR 61.92, "Standard"	A	Applies to the building demolition and waste handling activities.
"Emission Monitoring and Test Procedures," 40 CFR 61.93	A	Applies to the building demolition and waste handling activities.
"Compliance and Reporting," 40 CFR 61.94(a)	A	Applies to the building demolition and waste handling activities.
"Standards for Demolition and Renovation," 40 CFR 61.145	A	Applies to asbestos-containing materials encountered during demolition.
"Standard for Active Waste Disposal Sites," 40 CFR 61.154	A	Applies to asbestos-containing materials left in place during and following demolition.
"Rules for Control of Fugitive Dust," and "General Rules," IDAPA 58.01.01.650 and .651	A	Applies to the building demolition and waste handling activities.
RCRA and Idaho Hazardous Waste Management Act		
Generator Standards:		
"Standards Applicable to Generators of Hazardous Waste," IDAPA 58.01.05.006, and the following, as cited in it:		
"Hazardous Waste Determination," 40 CFR 262.11	A	Applies to waste that would be generated during the removal action and disposed of at the ICDF.
General Facility Standards:		
IDAPA 58.01.05.008, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," and the following, as cited in it:		
"Temporary Units (TU)," 40 CFR 264.553	A	Waste may be treated or temporarily stored in a temporary unit prior to disposal.
"Staging Piles," 40 CFR 264.554	A	Waste may be temporarily staged prior to disposal without triggering land disposal restrictions.
"General Inspections Requirements," 40 CFR 264.15	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility and to cover inspections under postclosure care.
"Preparedness and Prevention," 40 CFR 264, Subpart C	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility.

Table 14. (continued).

Requirement (Citation)	ARAR Type	Comments
"Contingency Plan and Emergency Procedures," 40 CFR 264, Subpart D	A	Applies to a facility staging, storing, or treating hazardous waste prior to transfer to the ICDF or an off-Site facility.
"Detection Monitoring Program," 40 CFR 264.98	A	Applies the groundwater monitoring network.
"Disposal or Decontamination of Equipment, Structures, and Soils," 40 CFR 264.114	A	Applies to contaminated equipment used to remove, treat, or transport hazardous waste.
"Post-Closure Care and Use of Property," 40 CFR 264.117	A	Applies to maintenance of the cover and monitoring network.
"Use and Management of Containers," 40 CFR 264.171–178	A	Applies to containers used during the removal and treatment of hazardous waste at the demolition site.
"Surveying and Recordkeeping," 40 CFR 264.309	A	Applies to installation of a cover.
"Closure and Post-Closure Care," 40 CFR 264.310	A	Applies to installation and maintenance of a cover.
Land Disposal Restrictions:		
IDAPA 58.01.05.011, "Land Disposal Restrictions," and the following, as cited in it:		
"Applicability of Treatment Standards," 40 CFR 268.40(a)(b)(e)	A	Applies to hazardous waste and secondary waste, if treatment is necessary to meet the disposal facility's waste acceptance criteria or if treatment is required because of placement.
"Treatment Standards for Hazardous Debris," 40 CFR 268.45	A	Applies to hazardous debris, if treatment is necessary to meet the disposal facility's waste acceptance criteria or if treatment is required because of placement.
"Universal Treatment Standards," 40 CFR 268.48(a)	A	Applies to nondebris hazardous waste and secondary waste, if treatment is necessary to meet the disposal facility's waste acceptance criteria or if treatment is required because of placement.
"Alternative LDR Treatment Standards for Contaminated Soil," 40 CFR 268.49	A	Applies to contaminated soil, if treatment is necessary to meet the disposal facility's waste acceptance criteria or if treatment is required because of placement.
Idaho Groundwater Quality Rules		
"Ground Water Quality Rule," IDAPA 58.01.11	A	The final configuration of the PBF must prevent migration of contaminants from the PBF reactor that would cause the Snake River Plain Aquifer groundwater to exceed applicable State of Idaho groundwater quality standards in 2095 and beyond.

Table 14. (continued).

Requirement (Citation)	ARAR Type	Comments
	TSCA	
"Decontamination Standards and Procedures: Decontamination Standards," 40 CFR 761.79(b)(1)	A	Applicable to decontamination of equipment with PCB contamination, if PCB waste is generated.
"Decontamination Standards and Procedures: Self-Implementing Decontamination Procedures," 40 CFR 761.79(c)(1) and (2)	A	Applicable to decontamination of equipment with PCB contamination, if PCB waste is generated.
"Decontamination Standards and Procedures: Decontamination Solvents," 40 CFR 761.79(d)	A	Applicable to decontamination of equipment used to manage PCB-contaminated waste, if PCB waste is generated.
"Decontamination Standards and Procedures: Limitation of Exposure and Control of Releases," 40 CFR 761.79(e)	A	Applicable to decontamination activities of equipment with PCB-contaminated waste, if decontamination is performed.
"Decontamination Standards and Procedures: Decontamination Waste and Residues," 40 CFR 761.79(g)	A	Applicable to management of decontaminated waste and residuals from PCB-contaminated equipment, if PCB waste is generated.
	CERCLA	
"Procedures for Planning and Implementing Off-Site Response Actions," 40 CFR 300.440	A	Applies to waste that is shipped off-Site for storage, treatment, or disposal.
	To-Be-Considered Requirements	
"Radiation Protection of the Public and the Environment," DOE Order 5400.5, Chapter II(1)(a,b)	TBC	Applies to the PBF reactor building before, during, and after the removal action. Substantive design and construction requirements would be met to keep public exposures as low as reasonably achievable.
"Radioactive Waste Management," DOE Order 435.1	TBC	Applies to the PBF reactor building before, during, and after the removal action. Substantive design and construction requirements would be met to protect workers.
"Region 10 Final Policy on the Use of Institutional Controls at Federal Facilities" (EPA 1999)	TBC	Applies if contamination is left in place at concentrations that preclude unrestricted access after completion of the removal action.

Table 14. (continued).

Requirement (Citation)	ARAR Type	Comments
A = applicable requirement; R = relevant and appropriate requirement; TBC = to be considered ARAR = applicable or relevant and appropriate requirement CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act CFR = *Code of Federal Regulations* DOE = U.S. Department of Energy EPA = U.S. Environmental Protection Agency ICDF = INEEL CERCLA Disposal Facility IDAPA = Idaho Administrative Procedures Act PCB = polychlorinated biphenyl PBF = Power Burst Facility RCRA = Resource Conservation and Recovery Act TSCA = Toxic Substances Control Act		

In addition to ARARs, there are other requirements that may be appropriate to the removal action. They are not classified as ARARs, because they are either not environmental regulations or they are environmental regulations that have administrative, rather than substantive, requirements. These requirements are described in the following paragraphs.

Section 106 of the "National Historic Preservation Act" (16 USC § 470 et seq.), as amended, requires agencies to consider the impact of undertakings on properties listed or eligible for listing in the National Register of Historic Places and to consult with the Idaho State Historic Preservation Office and other interested parties when impacts are likely. Section 110 directs federal agencies to establish programs to find, evaluate, and nominate eligible properties to the National Register of Historic Places, including previously unidentified historic properties that might be discovered during implementation of a project (36 CFR 800, "Protection of Historic Properties"). In addition, the "Archaeological Resources Protection Act" (16 USC § 470aa–470mm), as amended, provides for the protection and management of archaeological resources on federal lands.

The DOE-ID is required to review as guidance the most current United States Fish and Wildlife Service list for threatened and endangered plant and animal species. If, after reviewing the list, DOE-ID determines that Alternative 1 would not impact any threatened and endangered species, DOE-ID may determine or document that formal consultation with the United States Fish and Wildlife Service is not required for this action. The DOE-ID has determined that a biological assessment would not be required for any of the alternatives.

7.2 Compliance with Disposal Facility Waste Acceptance Criteria

7.2.1 INEEL CERCLA Disposal Facility Waste Acceptance Criteria

The ICDF is one option for disposal of the contaminated PBF reactor building waste. The waste acceptance criteria for the ICDF evaporation ponds can be divided into two main components: (1) contaminant-specific concentration or activity limits and (2) limits on the origin of the water. Based on analytical data available to date, the water from the PBF reactor building basin is expected to meet the contaminant-specific concentration or activity limits of the ICDF evaporation pond's waste acceptance criteria. Actual compliance with the concentration or activity limits would be established during implementation of the removal action.

The ICDF evaporation ponds are designated as a Corrective Action Management Unit, which is intended to handle water generated during ICDF operations. The ponds were recently constructed with a liner and a leachate collection system. A change would be required in the ICDF waste acceptance criterion that places limits on the origin of waters sent to the evaporation ponds in order for PER-620 basin water to be accepted there. For the purposes of this evaluation, it is assumed that this change can be made and would be acceptable to the public.

The ICDF is one option for the disposal of other waste generated during the removal action. The Staging, Storage, Sizing, and Treatment Facility (SSSTF) at the ICDF contains a storage/staging building, evaporation ponds, a waste shredder, solidification/stabilization tanks, and associated equipment. Waste generated at PBF that requires solidification or stabilization can be treated there to meet land disposal requirements, if it meets the SSSTF's waste acceptance criteria. The PBF waste not requiring treatment to meet land disposal restriction requirements can be sent to the ICDF disposal cell, if it meets the disposal cell's waste acceptance requirements. Based on data currently available for the PBF waste that would be generated, none of the waste sent to the ICDF, including the SSSTF, would require treatment prior to shipment to the facility.

7.2.2 Radioactive Waste Management Complex Waste Acceptance Criteria

Solid low-level radioactive waste from the PBF reactor building may be sent to the RWMC if the waste meets the RWMC's waste acceptance criteria. The Subsurface Disposal Area at the RWMC is a monitored landfill designed to accept both contact-handled and remote-handled low-level waste. The Subsurface Disposal Area low-level facility cannot accept hazardous waste. The waste acceptance criteria at the RWMC include radioisotope-specific concentration limits and activity limits. Based on information currently available, certain types of waste generated at PBF are expected to meet the RWMC's waste acceptance criteria.

7.2.3 Test Reactor Area Evaporation Pond Waste Acceptance Criteria

None of the water at the PBF and in associated vessels and lines has been determined to hold the characteristics of a hazardous waste, once no longer used for shielding, nor have any of the waters been determined to contain listed constituents. Once removed, the water would be categorized as a low-level radioactive waste.

The TRA evaporation pond (TRA-715) is available for the disposal of radioactively contaminated water meeting specific waste acceptance criteria. Noncontainerized water from sources, other than from the operation of the Advanced Test Reactor and associated water sources, is evaluated and approved on a case-by-case basis. The waste acceptance criteria at the TRA evaporation pond include radioisotope-specific concentration limits and activity limits. No RCRA hazardous waste is allowed. Based on information currently available, the water generated at PBF is expected to meet the TRA evaporation pond's waste acceptance criteria.

7.3 Achieving Removal Action Goals

The recommended Alternative 1 would meet the removal action objectives through removal of the abovegrade portion of the PBF reactor building (PER-620), removal of contaminated water in the PBF building and associated hot waste tank (PER-732), grouting of the remaining PBF building substructure to immobilize residual contaminants, and installation of a soil cover. This alternative would leave residual contaminant sources at the PBF reactor building location within the grout matrix. Immobilization of the contaminants in the building substructure through addition of grout inhibits/prevents migration of those contaminants from the facility and would provide protection from direct exposure. The soil cover over the grouted mass also would prevent access to the contaminants from surface receptors.

The removal action is expected to serve as the final action for the PBF reactor building and associated hot waste tank with an additional requirement for institutional controls. Institutional controls would be required after the removal action to maintain the soil cover.

8. REFERENCES

10 CFR 835, 2002, "Occupational Radiation Protection," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

10 CFR 835.101, 2002, "Radiation Protection Programs," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

10 CFR 835.1001, 2002, "Design and Control," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

36 CFR 800, 2004, "Protection of Historic Properties," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61, 2004, "National Emissions Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61.92, 2004, "Standard," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61.93, 2004, "Emission Monitoring and Test Procedures," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61.94, 2004, "Compliance and Reporting," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61.145, 2004, "Standard for Demolition and Renovation," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61.154, 2004, "Standard for Active Waste Disposal Sites," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 61, Subpart H, 2004, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register, July 2004.

40 CFR 141, 2004, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register, June 2004.

40 CFR 141.61, 2004, "Maximum Contaminant Levels for Organic Contaminants," *Code of Federal Regulations*, Office of the Federal Register, June 2004.

40 CFR 261.24, 2004, "Toxicity Characteristic," *Code of Federal Regulations*, Office of the Federal Register, May 2004.

40 CFR 262.11, 2004, "Hazardous Waste Determination," *Code of Federal Regulations*, Office of the Federal Register, April 2004.

40 CFR 262.34, 2004, "Accumulation Time," *Code of Federal Regulations*, Office of the Federal Register, April 2004.

40 CFR 264.14, 2004, "Security," *Code of Federal Regulations*, Office of the Federal Register, June 2004.

40 CFR 264.15, 2004, "General Inspection Requirements," *Code of Federal Regulations*, Office of the Federal Register, June 2004.

40 CFR 264.98, 2004, "Detection Monitoring Program," *Code of Federal Regulations*, Office of the Federal Register, June 2004.

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